

WaterWatch



WaterWatch
News of the Hydrology Section.

Editor: Mary P. Anderson, Department of Geology and Geophysics, University of Wisconsin-Madison, Madison, WI 53706 (408-262-2300).

From the Incoming President of the Hydrology Section

On July 1 I began my duties as president of the Hydrology Section of AGU. I took over a healthy Section, recognized as the leading scientific society in the field of hydrology. I also am taking over a Section whose position within AGU is strong and influential. These two facts are a tribute to my predecessors, Peter Engelson and Jim Wallis. They have shepherded the Hydrology Section through an important period of technical and political growth. I will try to maintain the pace.

During my tenure as president I intend to use our new WaterWatch column as a means of communication with the membership. I hope to keep you informed on the technical and administrative issues that arise and also to use this forum to solicit your views on directions that you would like to see us take. As a first attempt at this type of interaction, I have prepared a questionnaire, which appears below. If you have suggestions for technical sessions or Chapman Conferences, if you have views on the various AGU publication programs, or if you can suggest candidates for AGU awards, I urge you to fill out the questionnaire and return it to me.

In talking with people about the Hydrology Section at annual meetings, I find that most members have only a vague feeling for the administrative structure of the Section. I would like to try to strip away the mystery.

The Section is administered by an Executive Committee, which consists of the President, the President-Elect, the Past President, the Secretary, the Treasurer, the two *Water Resources Research* editors, the two *Annual Meeting Program* chairmen, the Chairmen of the 10 Technical Committees, and several at-large members. The day-to-day business is carried out by a subcommittee of the Executive Committee consisting of the President, the President-Elect, the Past President, and the Secretary-Treasurer. There is an election every 2 years for the position of Secretary-Treasurer, and Tom Maddock is currently serving his second 2-year term. There is also an election for President of the Section every 4 years, but the successful candidate serves 4 years in all, 2 as President-Elect and 2 as President. During my tenure, Marshall Moss is the President-Elect, and he will take over the presidency on July 1, 1985.

There are a variety of AGU publishing outlets available to members of the Hydrology Section, and it is important that we maintain liaison between these various outlets. For this reason, in addition to Ron Cummings and Steve Burges, who serve on the Executive Committee as the editors of *Water Resources Research*, I also intend to invite the Hydrology Associate Editor from *Environ. & Water Resources*, John Bredehoeft, and the Hydrology Associate Editor for *Reviews in Geophysics and Space Physics*, Bob Hirsch, to join the Executive Committee as at-large members.

The primary function of the Technical Committees is to organize the sessions at the two annual meetings. To this end, the chairmen of the technical committees will interact closely with the Spring Meeting (Eastern) Program Chairman, Len Komolov, and the Fall Meeting (Western) Program Chairman, Dennis Lettenmeier (through Dec. 31, 1984, after which he will give way to Soroosh Sorooshian).

In addition to the 10 Technical Committees,

there are also four Administrative Committees of the Section of Hydrology, each with a very specific annual or biannual task. These are the Horton Award Committee, the Fellows Committee, the Horton Research Grant Committee, and the Nominations Committee.

There are also a large number of AGU-wide committees, and the Hydrology Section has representatives on many of them. Of particular importance to us is the Horton Medal Subcommittees of the AGU Fellows Committee. The Horton Medal (not to be confused with our Section's Horton Award) is given in alternate years. For the 1986 competition, the Subcommittees will be chaired by John Bredehoeft.

R. Allan Freeze
President, Hydrology Section

AGU Hydrology Section Questionnaire

R. Allan Freeze began his term as President of the Hydrology Section on July 1, 1984. He is anxious to hear from members of the Section as to the directions they would like to see taken over the next 2 years. He is also eager to learn the names of people who might be willing to contribute to the Section or who ought to be considered for our honors and awards. If you could take the time to complete this questionnaire (or any part of it), please return it to:

R. Allan Freeze
Department of Geological Sciences
University of British Columbia
Vancouver, B.C. V6T 2B4, Canada

- Name: _____ Area of Research: _____
- Are you currently active in AGU? ☐ Yes ☐ No
If so, in what capacity? _____
If not, in what capacity might you be willing to participate? _____
- Can you suggest topics that you would like to see covered in technical sessions at annual meetings? _____
- Chapman conferences are smaller conferences designed for in-depth treatment of more specific topics. Can you suggest topics that might be suitable for the Chapman format? Possible convenors? _____
- Can you suggest interdisciplinary topics that might be suitable for joint sessions at annual meetings (or at a Chapman conference) with other AGU sections? _____
- The *Water Resources Research* series published by AGU is intended as an outlet for technology transfer. Can you suggest topics that might be suited to this type of treatment at this time? _____
- The new *WaterWatch* column in *Eos* is intended to provide an outlet for news and information of interest to members of the Hydrology Section. Do you have any suggestions regarding the content or format of the column? _____
- Water Resources Research* is AGU's primary outlet for research papers in hydrology. Do you have any suggestions regarding procedures or content? Can you suggest topics (and/or possible authors) for review papers? _____
- AGU Fellowship is conferred on scientists who have "attained acknowledged eminence" in their field. The number of Fellows in the Union cannot exceed 3% of the membership. Each Section is limited to three or less new fellows per year. Can you suggest the names of eminent hydrologists who ought to be considered for fellowship? _____
- The Horton Medal is given in alternate years by AGU to a senior scientist for "outstanding contributions" in hydrology. The most recent awardees have been John R. Philip, and C. V. Theis. Can you suggest the names of eminent hydrologists who ought to be considered for the Horton Medal? _____
- The Horton Award (not to be confused with the Horton Medal) is given each year by the Hydrology Section to a researcher who has published papers of "outstanding excellence in hydrology." The most recent awardees have been David Woolhiser and Lynn Gailher. Can you suggest the names of research hydrologists who ought to be considered for the Horton Award? _____
- The Macelwane Award is given to three awardees each year by AGU for "significant contributions by a young scientist." Recipients must be less than 36 years of age. The most recent awardees from the Hydrology Section were Raphael Bras in 1982. Can you suggest the names of any young hydrologists who ought to be considered for the Macelwane Award? _____
- Can you suggest the names of members of the Hydrology Section who would be effective committee members or possible candidates for future executive appointments? _____
- Any other comments or suggestions? _____

News & Announcements

Call for Contributions to WaterWatch

Contributions in the form of announcements, news items, and meeting reports, as well as letters to the editor, for the next edition of *WaterWatch* are due in my office on October 1. Publication is scheduled for mid-November.

Let me remind you that *WaterWatch* is published four times a year. I have set deadlines of January 15, March 15, July 1, and October 1 for receipt of material. A new editor will take over January 1.

Mary P. Anderson
Editor, *WaterWatch*

1984 Horton Research Grant Award

The recipient of the 1984 Horton Research Grant Award is Javier F. Samper. Samper is a graduate student in the Department of Hydrology and Water Resources at the University of Arizona-Tucson. The title of his research project is "A Methodology for the Combined Analysis of Hydrological, Hydrochemical, and Isotopic Data From Aquifers." His research advisor is Shlomo Neuman.

The objectives of his research are (1) to develop theoretical and computational tools for the spatial and statistical characterization of hydrochemical and isotopic data from aquifers and (2) to develop statistically based mathematical models incorporating hydrologic, chemical, and isotopic data to yield improved estimates of hydraulic and transport parameters as well as groundwater ages. Samper hopes to develop a workable mathematical framework which will allow a coordinated study of many types of hydrogeologic data, including hydraulic, chemical, and isotopic data. Such a systematically and mathematically based method of combined analysis for hydraulic, chemical, and isotopic environmental data is needed to develop a better conceptual understanding of the hydrogeology of any given area and to construct more reliable mathematical models for managing groundwater supply and quality.

Meetings

Modeling ET in Hydrology

A special session entitled "Evapotranspiration Modeling: Its Verification and Use" will be held during the AGU Fall Meeting in San Francisco, December 3-7, 1984.

This session will address modeling and characterization of evapotranspiration (ET) on a macro scale and is being sponsored by the Unsaturated Zone Committee. Many approaches to ET in hydrology in the past have regarded it as the residual component of the water balance, but, in most terrestrial applications, ET is the largest component of the local water budget. Causal theory has been developed on the micro scale and is not generally a linear fraction of events on a large scale. Recent theory provides help on macro scale. ET, F. Morton has recently compiled his thoughts on the complementarity of water availability for areal ET and potential ET and will give a presentation on how it works and how it can be used.

Wide area effects of energy input bear upon ET effects, and some effects need special characterization. Radiant energy interacts with canopy to present spectral signature effects from angle to sun and sensor. J. Norman will present data on the effect of these angles on albedo determination. Forests present a complex canopy to the environment. L. Priuhen will discuss problems and approaches of characterization and measurement of forest ET.

Models for applied hydrology must be compatible with the local causal mechanisms but must also integrate mechanisms regionally over a wide region. J. Williams will discuss application of models, and H. Moradpour will incorporate his work on two-phase flow into the evaporation process. J. Halfield will discuss verification of models, a process crucial to valid ET description.

Wide area ET requires wide area management of factors. Remote sensing offers the capability of synoptic and repeated measurements of many factors on a wide scale. R. Jackson will discuss the use of remote sensing in ET measurement. Some cases require allowance for variance in terrain and vegetation within the larger area. R. Clapp will discuss relationships of remote sensing to ET estimation in the humid eastern United States in those places where local anomalies in water flow path are important.

Characterization over wide areas ultimately involves mapping and correlation with local effects. R. Cuenca will describe this application and show maps for Oregon.

This program will be supplemented by volunteered papers. Prospective contributors should send three copies of an abstract as soon as possible to either R. J. Reginald, U.S. Water Conservation Laboratory, USDA-ARS, 4351 East Broadway, Phoenix, AZ 85040 (telephone: 602-261-4356) or J. F. Stone, Department of Agronomy, Oklahoma State University, Stillwater, OK 74078 (telephone: 405-624-6417), co-chairmen of the committee. In addition, an abstract original must be sent to Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009, by September 12, the Fall Meeting abstract deadline. Prospective contributors may address questions to either R. J. Reginald or J. F. Stone.

Petroleum Hydrocarbons

A conference on "Petroleum Hydrocarbons and Organic Chemicals in Ground Water—Prevention, Detection and Restoration" will be held Nov. 5-7, 1984 in Houston, Texas. The conference is being sponsored by the National Water Well Association and the American Petroleum Institute. The registration fee is \$225. For more information, contact Diana Sarnovsky, NWAA, 500 W. Wilson Bridge Rd., Worthington, OH 43085.

Eos

Transactions, American Geophysical Union
The Weekly Newspaper of Geophysics

For speediest treatment of contributions send three copies of the double-spaced manuscript to one of the editors named below and one copy to AGU.

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Cover. Disequilibrium partial melting in the Skaergaard intrusion, East Greenland. Skaergaard ferrogabbro adjacent to the basal contact of the later Basistoppen sill appears to have been partly remelted. The original ferrogabbro (notified) has been separated into an anorthositic gabbro (white inclusions) and a pyroxenitic gabbro (dark veins). The anorthositic gabbro is believed to be composed of the residual crystals from partial melting, and the pyroxenitic gabbro is believed to be the re-crystallized partial melt. The composition for the system FeO-CaO-SiO₂ may approximate the minimum melting composition for the plagioclase-free fraction of the ferrogabbro. Incomplete reaction between plagioclase and the partial melt resulted in a melt composition that does not correspond to the equilibrium eutectic for the system. The ice ax in the bottom right is marked in centimeters. (Photo courtesy of H. R. Nalund, Department of Earth Sciences, Dartmouth College, Hanover, NH 03755).

Organics in Soils

A symposium entitled "Mechanisms of Transformations of Organics in Soils, Sediments and Groundwater" has been organized as part of the 1984 International Chemical Congress of Pacific Basin Societies to be held Dec. 16-21 in Honolulu, Hawaii. The organizers are Donald Macalady (Colorado School of Mines), John A. Cherry (University of Waterloo), and A. Otsuki (National Institute for Environmental Studies, Ibaragi, Japan).

There will be five sessions during the symposium: Sorption, D. L. Macalady, presiding; Groundwater Processes, J. A. Cherry, presiding; Processes in Soils and Sediments, D. L. Macalady, presiding; Sorption, Transport, Diagenesis; General.

Meeting Report

Sediment Storage

The special session on "Sediment Storage in Rivers and Estuaries," which was held at the AGU Spring Meeting, included 14 papers, most of which discussed an aspect of sediment storage in rivers. Two papers, one by Brush and another by Smith, Shoemaker, and Miller covered topics in estuarine sedimentation. In general, the papers in the session could be divided into two main categories: Papers that discussed long-term sedimentation rates and methods of dating sediments, and papers that discussed locations and mechanisms of sediment deposition. Obviously, the time scale determines not only the methods of analysis, but also the scientific questions that are asked. This was demonstrated by the two summary papers. Meade discussed short-term sedimentation rates and the role that channel morphology and slope play in determining sites of sediment deposition. Trimble presented long-term models of sediment storage and erosion for different climatic zones.

There is much research that needs to be done in order to understand the processes of sediment deposition. Many of the papers presented in the session were case studies that detailed local controls on sediment storage. For example, Nolan and MacDonald in separate papers discussed how organic debris affects the movement and deposition of sediment. In order to be able to predict sediment storage adequately for sediment budget models, we will need a better understanding of the controls that nonalluvial features, channel morphology, gravel pavement, and other factors play in determining the sites and amounts of sediment deposition. These papers are another step in that direction.

Many of the papers on long-term sediment storage were at least indirectly concerned with methods of dating the material. The papers by Brown et al. and Pavich et al. added fuel to the continuing debate about the usefulness of ¹⁰Be in dating recent sediments and soils. Brakenridge discussed a case of progressive deposition on stream terraces in Tennessee that suggests that stream terrace trends are not necessarily time stratigraphic markers. Perhaps we will be able to understand stream terraces better when we understand the mechanisms of sediment deposition. For the present, however, we are still learning about depositional processes by examining the stream terraces.

This meeting report was contributed by Karen L. Prestegard, Franklin and Marshall College, Lancaster, Pa.

Hillslope Hydrology

A broad area of hydrology was discussed during the session on Hillslope Hydrology at the AGU Spring Meeting in Cincinnati. This is obvious by glancing through the abstracts, published in *Eos* (April 17, 1984, p. 215-216).

C. R. Amernman outlined the various flow processes at hillslopes observed in the North Appalachian Experimental Watersheds (Coshocton, Ohio). There the sequences of geological strata primarily determine the existence or absence of shallow water tables, subsurface flow, and springs in space and time. J. A. Lynch and E. S. Corbett (School of Forest Resources, Pennsylvania State University) and NEFES, U.S. Forest Service, respectively demonstrated the importance of antecedent soil moisture with respect to the run-off producing areas. Their experimental system allowed for sprinkling various parts of the whole area of a 7.9 ha forested watershed.

The response hydrographs showed two peaks, their timing depending on antecedent soil moisture (ASM). At low ASM the first peak occurred shortly after the cessation of rainfall, whereas at high ASM, peak flow lagged several hours behind the cessation of rainfall. Both presentations demonstrated once more the strenuous work involved in collecting reliable field data and making them available for further investigation. T. Dracos (ETH Zurich, Switzerland) used two-dimensional sand tank experiments to investigate fast groundwater response upon infiltration. He stressed the importance of hysteretic effects of the water-content-pressure relationship in the

capillary fringe immediately above the water table. R. E. Smith (USDA, Fort Collins) and R. H. B. Hebbert (University of West Australia) presented their model on flow processes at the hill slope scale and compared its performance with piezometer response data that were observed in an Australian watershed. They also outlined some model applications including the assessment of soil salinity. C. B. Burke (Hazen Engineering Co., Chicago) and D. D. Gray (West Virginia University, Morgantown) introduced a finite element computer model that combines subsurface, overland, and open channel flow. They discussed the effects of layered soils on the resulting stream hydrograph as well as the impacts of rainfall characteristics and antecedent moisture conditions on it. K. M. Loague and R. A. Freeze (University of British Columbia) concluded the session with disenchanted comparisons of three different rainfall-runoff modeling techniques (i.e., regression model, unit hydrograph model, and quasi-physically based model) on small upland catchments. They hope to improve the performance of the three models by refining the spatial arrangement of the rain gauges.

The aspect of hydrological experiments and measurements at the hill slope scale fell somewhat short, and several of the presentations would also have fit into a program of a session on Catchment Hydrology as well. The vivid discussions, however, indicated the interest in the topics presented. Despite the fact that the program was shortened by the cancellation of two previously scheduled papers, there was time to appreciate fully all the contributions from the 50 to 70 participants.

This meeting report was contributed by Peter F. Geissmann, Department of Environmental Sciences, University of Virginia, Charlottesville, Va.

Miscible and Immiscible Transport in Groundwater


The current conventional theory for transport of solutes in groundwater was fully developed by the 1960's. Attention then focused on the development of analytical solutions to the governing equation. By the late 1960's, the increasing efficiency of digital computers, coupled with the restrictive assumptions required for analytical solutions, led to a major emphasis on developing deterministic, distributed-parameter, numerical simulation models. Several numerical models that solved the conventional solute-transport equation were developed in the early 1970's and initially applied to seawater-intrusion problems. Toward the middle and late 1970's, many applications involved hazardous and radioactive waste disposal problems. Almost all of these applications involved miscible transport. With the increased application of transport models to field problems, certain deficiencies in transport theory were identified. The deficiencies included the mathematical descriptions of hydrodynamic dispersion, reaction processes, and flow and transport in fractured rocks. Therefore, in the latter half of the 1970's and the beginning of the 1980's, considerable research was and continues to be directed toward improving our understanding of these processes in the saturated zone.

Also, in the 1980's, work increasingly focused on immiscible transport as more and more waste disposal sites were observed to contain nonaqueous phase liquid (NAPL), and oil spills were noted with increasing frequency. In the first case, some commonly disposed chemicals, such as chlorinated hydrocarbons, are often denser than water, whereas oil or petroleum products are usually lighter than water. Both problems involve immiscible transport.

Because of the interest in these topics, a special session on "Miscible and Immiscible Transport in Groundwater" was included in the program of the 1984 AGU Spring Meeting. The papers covered a wide variety of research topics including (1) flow and transport in fractured rocks, (2) combining geochemistry with groundwater flow and transport, and (3) miscible transport of multiple species. In addition, a panel of experts was assembled to discuss the process of hydrodynamic dispersion. Several questions were addressed: (1) How much have we learned in the last 10 years? (2) Why do most available models still use the conventional dispersion theory despite observed discrepancies? (3) Do new theories require too much field data to be practical?

The papers that considered miscible transport included several that emphasized chemical processes. These reflect the need to incorporate chemical reactions into transport models. Different types or classes of reactions require different mathematical treatment. Sorption has commonly been represented by a distribution coefficient (*K_d*). However, in many cases this approach inadequately describes the actual chemical processes and the observed chemical changes.

Among the other papers on miscible flow were several that mainly emphasized the physical aspects of the problem. One presentation by T. Dracos (ETH Zurich, Switzerland) used two-dimensional sand tank experiments to investigate fast groundwater response upon infiltration. He stressed the importance of hysteretic effects of the water-content-pressure relationship in the



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can be successfully used for the analysis of field-scale experiments. Another considered a stratified aquifer in which the vertical component of velocity is zero. It was then suggested that scale-dependent dispersion coefficients are a function of various averaging processes and of our knowledge (or perhaps, ignorance) of the three-dimensional spatial distribution of the groundwater seepage velocities. Considerable work has recently been done on immiscible transport. Many of the theoretical concepts and modeling approaches pertaining to this problem had originated in the petroleum industry. However, because of the different physical environment of deep petroleum reservoirs compared to shallow aquifers, as well as different incentives and areas of concern in the petroleum industry, there is a great need to adapt and extend this work. Also, the physical, chemical, and hydrologic processes and data needs that are unique to the scale and environment of shallow groundwater systems need to be investigated.

Several papers on immiscible transport focused on numerical models. Most considered three phases: air, water, and nonaqueous liquid. Some included physical, chemical, and biological processes. Some were capable of simulating the movement of an organic in all three fluid phases. Solution of the resulting system of equations is clearly not a trivial exercise.

As was indicated by the various models presented, we have come a long way in the past few years in our capability of simulating multiphase flow. A variety of computer codes now exist, but, as many authors have pointed out, the necessary input data do not exist. Only one set of relative permeability curves was presented, and this was for TCE. This type of data does not exist for most solvents and chlorinated hydrocarbons found at spill sites or landfills. In addition, to characterize sites where nonaqueous liquids exist, in situ water and nonaqueous liquid saturations need to be measured or determined. Such data do not exist at these sites. Therefore, the next major advance in this problem area may not come until this type of data becomes available.

The Panel on Dispersion included five internationally recognized experts on dispersion: Emil O. Frind (University of Waterloo), Robert A. Greenkorn (Purdue University), Lynn W. Gelhar (Massachusetts Institute of Technology), Fred J. Molz (Auburn University), and George F. Pinder (Princeton University). The discussions focused on the strengths and weaknesses of the conventional representation of dispersion as a Fickian process (that is, the dispersive flux is proportional to a dispersion coefficient and the concentration gradient). There was a general consensus that the observed dispersion in the field represents the integrated effects of a variety of phenomena or processes that can lead to scale-dependent non-Fickian dispersion.

It is clear from the symposium that the theory and practical applications of the theory regarding chemical transport in groundwater represent a relatively young and still evolving science. First, the conventional equations do not always describe the processes adequately. Second, available numerical methods do not always solve the equations accurately and efficiently. Third, we never have enough data to describe the field situation unequivocally (both for physical and chemical parameters and for observations of dependent variables).

This meeting report was prepared by James W. Mercer, *Geotronics, Inc.*, and Leonard F. Konikow, *U. S. Geological Survey*.

Water Watch (cont. on p. 692)

Water Watch (cont. from p. 691)

Kiesel Memorial Lectures

The third Kiesel Memorial Lecture was given on February 23, 1984, by John D. Breckinridge of the U.S. Geological Survey. The title of his talk was "Water Management: Who are the Managers?"

The text of the second Kiesel Memorial Lecture, which was delivered by Myron Fiering of Harvard University on March 10, 1983, is now available from the Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721. The cost of the 20-page booklet is \$3.00 per copy, and checks should be payable to the University of Arizona. The title of Fiering's talk was "The Real Benefits from Synthetic Flows: Reflections on 25 Years With the Harvard Water Program." According to the foreword by Nathan Buras of the University of Arizona, "The second Kiesel Memorial Lecture captures, in a sense, the kernel of the quantum jump which occurred in the late fifties and early sixties in our perception of the complexities of the hydrological phenomena and man's relation to them." According to Buras, "In the sixties, young Ph.D.'s sallied forth from their universities into the real world spreading the good news that, at last, complex water resource problems in which imperfectly understood natural phenomena are affected by anthropogenic interventions can be neatly dissected by the application of systems analysis and the use of mathematical models. . . . The second Kiesel Lecture presents and dissects a philosophical basis which underlies the discipline called 'water resources.' The philosophical basis, together with the scientific foundation provided by hydrological sciences, are the conceptual framework within which the development and utilization of regional water resources take place."

Field Methods for Supporting Groundwater Chemical Transport Models

The growing realization that many of the challenging questions regarding contaminant transport in groundwater must be resolved by careful field experiments, led to the convening of this symposium, which was sponsored by AGU's Groundwater Committee. The half-day symposium was held during the recent spring AGU meeting and attracted around 150 individuals.

The 13 papers presented included five invited talks. A list of authors and complete abstracts can be found in *Eos* (65, April 17, 1984, p. 206). Three papers discussed the results of controlled field tracer tests performed at the Chalk River Nuclear Laboratory and Burden landfill sites in Ontario, while three other papers covered tracer tests (one involving the use of heat as a tracer) at sites in Alabama and Illinois. One of the tests at the Chalk River site included the equivalent of 750,000 point measurements of iodine-131 during a natural gradient tracer test at distances as far as 40 m from the injection well. These papers demonstrated that dispersion in principle can be described by the classical advection-dispersion model provided that accurate three-dimensional velocity and permeability distributions are measured. . . . This is done, the resulting dispersivities are not scale dependent and are quite close to laboratory measurements. The papers also demonstrated that organic contaminants may be subject to chemical nonequilibrium processes during transport.

Three papers discussed on-going long-term tracer studies. D. B. Stephens described an

ambitious field experiment at Socorro, N. M., designed to collect data for studying the three-dimensional nature of dispersion in unsaturated media at a scale representative of electric utility waste seepage problems. The experiment will involve the pulsed application of water and tracer over a 900 m² area for at least 2 years. Instrumentation will include neutron moisture probes, porous cup samplers, tensiometers, and chemistries placed throughout a 40-m-thick unsaturated zone. D. L. Fryberg described an on-going study funded in part by the U. S. Environmental Protection Agency involving Stanford University and the University of Waterloo. A natural gradient tracer test is being performed at the Burden Landfill site in Ontario, where in August 1982 a solution containing two inorganic tracers and five halogenated organic compounds was injected into the aquifer during a 15-hour period. Since then, solute plumes have been monitored by using multi-level sampling devices. O. Güven described a tracer study being performed in a confined aquifer near Mobile, Alabama. This study is being funded by the U. S. Environmental Protection Agency and is designed to measure the vertical and lateral variations of horizontal hydraulic conductivity by measuring the vertical variation of horizontal seepage velocities in the vicinity of fully penetrating injection wells operating at 15 ft. The long-term objective of the experiments is to develop field methods to quantify the major advective aspects of solute transport which seem to be the dominant dispersing mechanism in many aquifers.

Another paper dealt with measurement of groundwater velocity using a downhole conductance electrode in a flow cell which measures the dilution of a salt tracer. The remaining three papers dealt with analyses of field data collected to assess existing contamination problems. These papers included dis-

cussions of problems at an unlined hazardous waste site, at a facility for uranium mill tailings, and at the Chalk River Nuclear Laboratory.

The most fundamental problem in quantifying solute transport is the high degree of anisotropy and heterogeneity of natural aquifers. The paper by Killey and Molenaar strikingly demonstrated that there is hope for measuring such variations, although it may be a long time before such methods become practical for widespread use. Moreover, several papers described three-dimensional experiments or analyses, implying that many are abandoning the habit of averaging aquifer properties in the vertical direction, an approach which causes serious conceptual difficulties when applied to contaminant transport. It seems that many groundwater contamination problems are intrinsically three-dimensional.

Despite overwhelming measurement difficulties, it appears that existing knowledge can be applied in a useful way to solve groundwater contamination problems. The paper by Schalla et al. for example, described how an interactive and interdisciplinary approach including data gathering, kriging, model calibration, and computer simulation resulted in an evaluation of a contamination problem adequate for the design of a remedial action alternatives. Although such successes are encouraging, perhaps the most important conclusion of this special session was that sophisticated field measurements are necessary in order to understand the complex phenomena associated with solute transport in groundwater in a way that will allow for a general quantitative approach to be developed.

This meeting report was written by Fred J. Moly, Auburn University, Auburn, Ala., and Mary P. Anderson, University of Wisconsin-Madison, Madison, Wis.

served stratigraphy; he integrates this with some models which define physical constraints of eruptive processes and produces a number of interesting tectonic speculations.

Terry Klein is with the U.S. Geological Survey, Reston, VA 22092.

Revolution in the Earth Sciences: Advances in the Past Half-Century

Shelby J. Boardman (Ed.), Kendall/Hunt Publishing, Dubuque, Iowa, viii + 385 pp., 1983, \$23.95.

Reviewed by James T. Gutmann

This volume is the preceedings of a symposium held at Carleton College to celebrate the 50th anniversary of the Department of Geology and to honor the founder of that department, Larry Gould, later the president of Carleton and long an internationally prominent figure in the area of polar research. The title of the volume may lead some to anticipate a more comprehensive treatment of the "revolution" than its articles provide. However, its stated purpose is to illuminate just how the substantial changes of recent decades came about in each of a wide variety of areas within earth science, in effect providing a case study of the revolution. In this it succeeds admirably.

The dramatic evolution of ideas in geosciences is not directly treated here; indeed, it would be difficult to say much that is new in doing so. Instead, most of the 31 articles in this paperback volume focus on developments in specific fields ranging from experimental rock deformation (considered by Tullis and Tullis) to the geology of Antarctica (by Rowley). A noteworthy and distinguishing feature of this collection is that the articles provide lucid reviews at a level accessible to undergraduates. Especially valuable for their concise treatment of major areas are papers on advances in high pressure experimentation (by Bishop), on the development of ideas about Archean tectonics (by Southwick), on current thinking about Precambrian crustal evolution (by Ernst) and on the application of

radiogenic isotope systems to geochronology and petrogenesis (by Bickford). Similarly, Hanoor describes the development of thinking about subsurface sedimentary basins, Carson reviews ideas on sediment deposition and deformation at convergent margins, and Collier discusses the renaissance in invertebrate paleontology. Also present are excellent papers on aspects of geomorphology, hydrogeology, archaeological geology, venous tectonics, and 11 articles on topics in economic geology and mineral and energy resources. Among the latter, all of which are very clearly written, a paper by Albers on the leadership role of the U.S. Geological Survey in meeting national mineral and energy needs is particularly recommended.

This volume is uniformly well edited and illustrated. It honors both Gould and the department, for all its contributing authors are Carleton alumni or faculty. The volume should be in the libraries of all geology departments because of the insights its articles provide concerning the evolution of ideas in so many areas of earth science. From these articles comes a sense of the extent to which major strides forward have depended on technological advances and/or new viewpoints commonly resulting from interdisciplinary studies. Particularly in the case of Antarctica, a third influence must be added: the spirit of international cooperation in scientific research fostered by the man to whom this volume is dedicated, Laurence M. Gould.

James T. Gutmann is with the Department of Earth and Environmental Sciences, Wesleyan University, Middletown, CT 06457.

Early Proterozoic Geology of the Great Lakes Region

L. G. Meadeis, Jr. (Ed.), *Mem. 160, Geological Society of America*, Boulder, Colo., VI + 142 pp., 1983, \$28.00.

Reviewed by J. Kalliohoki

Interest in the Precambrian geology of the Great Lakes Region has been growing as documented by a new generation of multi-auth-

ored books. Two have been published recently by the volume under review and a companion volume, *Geology and Tectonics of the Lake Superior Basin*, *Mem. 156*. The Minnesota Geological Survey has published a regional Precambrian geological map at a scale of 1:1,000,000, and in 2 years' time newer data will appear in a DNAG (Decade of North American Geology) volume on the Precambrian of the conterminous United States. Thus, the papers in the volume under review provide a comprehensive view of the status of geological knowledge as it existed in the spring of 1981.

In the lead paper P. K. Sims and Z. E. Peterman guide the reader in a few pages through the subtleties of major regional geological features. The Animikie basin developed by faulting and foundering of the general boundary between an Archean granite-greenstone terrane on the north and an older Archean gneissic terrane on the south. This basin received sedimentary fill that thickened southward, and, in Michigan, volcanic rocks are intercalated with these sediments in the deeper parts of the basin. In Wisconsin the basin was filled almost entirely by lavas. The intensity of the subsequent Penokean orogeny (1,880-1,770 m.y.) recorded in the super-crustal and basement rocks, increased southward, and tectonic transport was directed to the north. Sims and Peterman distinguish two parallel geological regions on the south side of the Penokean fold belt, based on differences in structural and metamorphic patterns, but in 1981 they considered both tectonic zones to be part of a single orogen.

G. B. Morey provides details missing from the lead paper. He described the lateral and vertical variations in thickness and lithology of the fill in the western part of the Animikie basin and proposes a tectonic model of extension during sedimentation followed by compression in the succeeding Penokean orogeny.

Jeffrey K. Greenburg and Bruce A. Brown make a very strong point in their paper: It is possible to distinguish two lower Proterozoic terranes on the basis of contrasting geological characteristics. In the northern Wisconsin terrane, mostly in Michigan, Udoletic, lavas and gabbro sills occur with sedimentary rocks. In the Penokean volcanic belt, entirely in Wisconsin, the lavas are calc-alkaline with many

associated calc-alkalic plutons, but with only minor sedimentary rocks. They conclude that these two contrasting terranes may represent tectonostratigraphic plates that converged along the approximate site of the Niagara fault.

The purported collision zone is analyzed by D. K. Lurie who recognizes distinct tectonostratigraphic terranes on either side of the fault. The very complex early Proterozoic style in the southern terrane, south of the Penokean volcanic belt, is documented by R. S. Mason.

Eugene L. Smith reports on four chemically and mineralogically distinct rock suites dated at 1.7 b.y., that may be the only surface expression in the area of a felsic volcanic terrane that can be traced in the subsurface possibly as far as western Arizona. R. H. Dott, Jr., describes the distribution and composition of three similar redbed quartzites, the Baraboo, Sioux, and Barron, that fell into the time span of 1.4-1.7 b.y. He proposes that because of their maturity and great thickness they were deposited along a passive continental margin, and because of the severity of their deformation, there may be a suture zone under northern Iowa and Illinois. In an important new contribution on the origin of iron formations R. W. Ojakangas describes the vertical distribution pattern of characteristic clastic facies in stratigraphic sequences that underlie two major iron formations in the western part of the Animikie basin. He concludes that the iron formations probably were deposited on a subtidal-shelf environment.

The memoir contains an excellent collection of papers that covers the subject quite well. Those who have some knowledge of Lake Superior region geology will recognize quickly that these papers represent major advances in the quality of data and in their interpretation. The introduction of plate tectonic concepts to this Proterozoic terrane is new and has not provided clear solutions to long-standing geologic problems. What it has provided is a fresh perspective on, and appreciation of, these old problems, and an element to geological meetings and to the literature.

J. Kalliohoki is with the Department of Geology and Geological Engineering, Michigan Technological University, Houghton, MI 49931.

News (cont. from p. 689)

Upcoming Hearings in Congress

The following hearing has been tentatively scheduled by the Senate. Dates and times should be verified with the committee or subcommittee holding the hearing; all offices on Capitol Hill may be reached by telephoning 202-224-3121. For guidelines on contacting a member of Congress, see AGU's *Guide to Legislative Information and Contacts* (*Eos*, August 28, 1984, p. 669).

September 24: Hearing on Antarctica by the Science, Technology, and Space Subcommittee of the Senate Commerce, Science, and Transportation Committee. Room SD-235, Russell Senate Office Building, 9:30 A.M.—BTR

Meissl Memorial Senior Scientist

Beginning in 1976, the Committee on Geodesy of the National Academies of Sciences/National Research Council has administered a Senior Scientist Program supported by the National Geodetic Survey of the National Oceanic and Atmospheric Administration (NOAA). Under this program, awardees have spent up to a year in residence at the National Geodetic Survey, conducting research in geodesy and related fields. Through the summer of 1984, 15 prominent scientists have participated, producing more than 20 papers published in a NOAA publications series or in professional journals.

The second awardee was Peter Meissl, Professor of Geodesy at the Technical University of Graz, Austria, who spent 8 months during 1977 at the National Geodetic Survey. His work, "A Priori Prediction of Roundoff Error Accumulations in the Solution of a Super-Large Geodetic Normal Equation System," was released as a NOAA professional paper, published hardbound as an acknowledgment of the permanence of the achievement. His contribution was so outstanding that he was invited to return for the summer of 1982. But, tragically, in May 1982 he was killed in a mountain-climbing accident near Graz.

The Committee on Geodesy and the National Geodetic Survey are continuing this program, and the Committee is currently considering applications for periods after 1985. As a tribute to Peter Meissl, a most distinguished scientist, the program henceforth will be formally designated the Peter Meissl Memorial Senior Scientist Program.

For more information, contact Bernard H. Chovitz, Chief Geodesist, NGS/NOAA, Rockville, Md. 20852 (telephone: 301-443-8531).

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Books

Rock-Forming Minerals

W. A. Deer, R. A. Howie, and J. Zussman, vol. 1A, *Orthosilicates*, 2nd ed., Longman, New York, ix + 919 pp., 1982, \$149.95.

Reviewed by J. Stephen Huebner

Volume 1A is the second of a series of revisions that the authors are preparing from their original five-volume work on rock-forming minerals, which is a standard reference for petrologists and mineralogists. Revision of the original series is necessary because of the explosion of the mineralogical literature, particularly in the specialties of microprobe chemical analysis, electron microscopy, intercrystalline and intracrystalline element distributions, mineral physics and thermodynamics, and phase equilibria. Many of these fields or techniques were only in their infancy when the first edition was prepared 20 years ago. The increase in the published literature has been so great that volume 1A requires 5 times as many pages to deal with one half of the mineral species covered in volume 1 of the first edition. For example, mullite, which was only mentioned briefly in the sillimanite section of the original edition, is now allotted its own 17-page section. Clearly, this second edition supplants the first with regard to scope and quantity of material covered.

Each section describing a particular mineral or mineral group includes an introduction, descriptions of the crystal structures and distinguishing features, and a reference list. Chemical compositions, cation distributions, experimental studies, physical properties, and paragenesis are summarized for each mineral species. The sections on chemistry, cation distributions, and references are enlarged dramatically from those of the first edition. Surprisingly, the sections on distinguishing features are little changed and, as a rule, do not take advantage of new microprobe and electron microscopy techniques that help make definitive identifications.

The authors collect and summarize, but do not purport to evaluate, the literature. Their mode of presentation is one of vignettes, each a sentence to a paragraph long, summarizing a cited paper. Many vignettes are accompanied by reproductions of original figures. It is up to the reader to synthesize, to build bigger ideas from the collected facts. Little attempt is made to estimate the quality of the information, a task that will be obvious to specialists but that might prove misleading to workers from other fields of science.

The highly structured organization is important because the index does little to help the reader locate particular topics. The index regurgitates the headings within the text but adds few entries. It is little more than a table of contents, arranged alphabetically. For example, if a subject such as diffusion in olivine does not warrant a heading, it is not likely to appear in the index, even though it may be discussed. (Self diffusion and interdiffusion do appear, however.) At almost 300 pages are devoted to olivine alone; knowledge of

the highly structured organization is necessary to find information hidden within the text. Several minutes of time will be well spent in comprehending the author's scheme of organization.

Volume 1A is an excellent doorway into the mineralogical literature. It may also be the last authoritative book on orthosilicates in a field that in the future may rely upon microfiche and computer files. The reference lists are fabulous. Where else can you find 1579 printed references to forsterite-fayalite? Or for that matter, 252 complete chemical analyses of garnets? With its companion volumes, 1A is the single most convenient reference to, and summary of knowledge about, the major rock-forming minerals. It should be available for consultation by all mineralogists, petrologists, and, because of the newly increased coverage, geophysicists who are interested in the physical properties of such minerals. The cost is prohibitive for most individuals, but most libraries and some specialists will want to acquire these volumes. This new edition will be particularly valuable for institutions that have no machine-searchable reference base or that lack the primary literature from which the information in volume 1A is drawn. In such institutions, volume 1A will identify the papers that individuals doing research should obtain first.

J. Stephen Huebner is with the U.S. Geological Survey, Reston, Virginia.

Komatiites

N. T. Arndt and E. G. Nisbet (Eds.), *George Allen & Unwin*, Boston, Mass., xvii + 526, 1982, \$75.00.

Reviewed by Terry Klein

Since komatiites were first described in 1969, we have wondered what they are, what they look like, where they are, and how they got there. Arndt and Nisbet's well-edited, well-illustrated volume provides a good basis and excellent resource book for the geologist that wants to know more.

Komatiites, an outgrowth of the 1979 Penrose Conference held in Val d'Or, Quebec, consists of seven parts with 29 chapters by 44 authors. Each part has a helpful editorial introduction that gives background citations, lends historical perspective, and summarizes the section's content. The book's purpose—"to summarize our present knowledge of komatiites"—is accomplished well. Because the proliferation of literature has slowed since the 1970s, only a few significant papers published after 1981 are missing from the reference citations.

Appropriately, Viljoen and Viljoen, who first used the term "komatiite" to describe ultramafic volcanic rocks from Barberton Mountain Land, wrote a good historical review for the introductory section. In chapter 2, editors Arndt and Nisbet answer the oft-asked question, "What is a komatiite?" The editors' simple definitions of komatiites, and their associated rocks provide consistent

terms that unify the concept of komatiite for the reader.

The 12 short chapters of part 2 (Regional Surveys) exemplify the wide distribution of komatiites. Viljoen et al., Bains et al., and Auvray et al. wrote good summary papers, and other brief chapters contain helpful reference lists.

Part 3 has one chapter, Spinifex-Textured Komatiites: A Review of Textures, Mineral Compositions and Layering, by C. H. Donaldson.

Donaldson's excellent, well-illustrated paper summarizes the physical and chemical characteristics of the most striking aspects of komatiites; their spinifex textures and the well-developed mineralogical and chemical layering exhibited by individual flow units.

Part 4 (Alteration and Metamorphism) illustrates the difficulties that accompany textural and geochemical studies of komatiites. In the first chapter of part 4, W. T. Jolly discusses the metamorphism in the Abitibi belt that altered the komatiites and related rocks. Beaty and Taylor's companion article deals with oxygen isotope variation in komatiites.

The volume's substance lies in part 5; five papers use komatiite geochemistry to attempt to describe the Archean mantle and the evolution of ultramafic magmas. Bassick examines chemical variations from classic komatiite localities and offers several useful techniques for examining original magmatic variations in highly altered komatiite suites. In an excellent chapter, Smith and Erlank suggest the possibility that different komatiite lineages exist and discuss the heterogeneity of sources and the changes in magmatic processes with time. A good summary chapter by Fialter shows the usefulness of the Sm/Nd isotope system in determining the age and evolution of komatiites. Arndt and Nisbet give additional information on the origins of dioritic basalts and basaltic komatiites in the well-studied Munro Township area.

Although part 6 (Economic Geology) has only three papers, the number of papers in no way reflects on the quality. Naldrett and Campbell discuss the physical and chemical models of komatiite-associated nickel deposits, and Keays explores the use of platinum group metals as tools for understanding the origin of magmatic sulfides. Both are excellent papers. Pearson's chapter on the occurrence of Au and Sb mineralization illustrates the widespread, but largely unappreciated, occurrence of quartz-carbonate alteration in mafic and ultramafic rocks and Au deposits.

In the final part, two papers provide interesting reading. Bickle presents three methods of estimating the MgO content of the original erupted liquid and concludes that flow margins are most representative. Flow margins, however, are easily altered and should be evaluated carefully.

Nisbet states in the final chapter "the tectonic setting of komatiites is still fertile ground for speculation on small tectonic basins." Nisbet summarizes aspects of the nature of the Archean basement, the strength of the lithosphere, and implications of ob-

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For more information, call 202-462-6003 or toll free 800-434-2488.

POSITIONS AVAILABLE

Scripta Institution of Oceanography/Marine Geophysics. The Scripta Institution of Oceanography invites applications for a tenure track position in solid-earth geophysics/geomorphology. The level of the appointment will depend on the applicant's qualifications. Candidates will be expected to supervise and conduct research in geophysical studies or oceanography with emphasis on the ocean basins and their margins. The position will also involve graduate level teaching and the supervision of graduate student research. Applicants must hold Ph.D. degree and have demonstrated excellence and independence in research in geophysics/geomorphology. Associate or Professional level candidates must show evidence of strong research record in their specialization. Assistant level candidates will be expected to show evidence of their potential through publication record appropriate for their experience and letters of recommendation. Send letter of application including description of research interests, list of publications, resume of teaching experience, and names of at least three references to: Chairman, Graduate Department, A-008, Scripta Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093. Closing date for applications is 15 October 1984. We expect to fill the position in calendar year 1985.

An Equal Opportunity/Affirmative Action Employer. Women and minorities are especially invited to apply.

Postdoctoral Research Position/Petrology-Geochemistry. Northern Illinois University, Department of Geology. Recent Ph.D. recipient is sought for one year position starting in early 1985. Strong analytical background in XRF or plasma spectrometry is preferred. The Department of Geology is in the process of acquiring new, automated XRF and plasma spectrometers. The successful candidate will be involved in the development of sample-preparation, analytical, and data-reduction procedures as well as instruction of other students in geochemical research will be expected. The Department also has solid- and gas-source mass spectrometers, automated EMP, and excellent computer facilities. Please send application, resume, and the names of three references to J. H. Berg, Department of Geology, Northern Illinois University, DeKalb, IL 60119. Application deadline is October 15, 1984.

Northern Illinois University is an affirmative action equal opportunity employer.

Satellite Geodesist. The scientific staff position available 1 October 1984 at the Space Research Institute of Technology, Department of Earth, Atmospheric, and Planetary Sciences, is a federally sponsored long-term program of research in geodesy via satellite interferometry with Global Positioning System (GPS) satellites. Candidates must have Ph.D. in geodesy, and ability and experience in radio interferometry with satellites, as demonstrated by substantial refereed publications and conference reports. Experience in FORTRAN scientific programming, in statistics, in the theory of satellite geodesy, and in parameter estimation techniques applicable to large, multi-parameter problems is essential. Candidates must be performing field work and in data processing on large IBM mainframe and/or small PDP-11 computer systems would be helpful, as would knowledge of the GPS geodetic reference systems, and network adjustments. Strong skills in oral and written presentation of research results are required.

Please send vita, including list of publications, salary requirements, and references, plus reprints of major publications to: Professor Charles C. Counselman, III, c/o L.M. Brichelet, Personnel Office, E19-238, MIT, Cambridge, MA 02139.

MIT is an affirmative action/equal opportunity employer.

The University of Kansas/Faculty Positions. The University of Kansas, Department of Geology seeks to fill three tenure track positions at the Assistant Professor level to begin in Fall, 1985. The Department seeks persons committed to academic careers involving teaching, research, and service. Salaries will be determined by qualifications and experience and will be competitive with other departments. Ph.D. degree in Geological Sciences or have it near completion.

All positions carry responsibility for teaching at both undergraduate and graduate level, conducting research programs of research and publication, and supervising the research of students. Candidates should expect to teach introductory courses as well as in their specialties. The Department may give preference to those who are qualified physically and have training or experience to teach in our summer field programs and have the capability to use the computer to solve geologic problems.

Position 1. Geomorphology, with interests in sedimentology, crustal structure, or potential fields. Candidates should expect to interact with a strong group in the Kansas State Geological Survey and coordinate the academic aspects of the program in geomorphology. Duties will include teaching courses in geomorphology, crustal structure, or tectonics.

Applicants should send a resume, academic transcripts, and at least three letters of recommendation to: M.E. Bickford, Chairman of Search Committee, Department of Geology, University of Kansas, Lawrence, Kansas 66045-9294. Application materials should be received by 5:00 p.m. November 18, 1984. The positions are contingent upon availability of funds.

The University of Kansas is an AA/EEO employer and encourages applications from all qualified persons.

University of Texas at Austin. The Department of Geological Sciences seeks to fill tenure track positions effective fall 1985 in one or more of the following disciplines: 1) micropaleontology, 2) tectonics, 3) structural geology, 4) sedimentology, 5) hydrogeology, and 6) paleogeography. Candidates must have a Ph.D. in geology, and ability and experience in radio interferometry with satellites, as demonstrated by substantial refereed publications and conference reports. Experience in FORTRAN scientific programming, in statistics, in the theory of satellite geodesy, and in parameter estimation techniques applicable to large, multi-parameter problems is essential. Candidates must be performing field work and in data processing on large IBM mainframe and/or small PDP-11 computer systems would be helpful, as would knowledge of the GPS geodetic reference systems, and network adjustments. Strong skills in oral and written presentation of research results are required.

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Stanford University/Plasma Physics, EM Waves, Space Physics. We are seeking a senior person who has demonstrated exceptional scientific and leadership qualifications in one or more of the following disciplines: Space Plasma Physics, electromagnetic waves, and solar-terrestrial physics. We expect the successful candidate to have an outstanding reputation documented through professional writings or other evidence of personal technical creativity, letters of reference from recognized research leaders in the disciplines mentioned above, and/or awards and other recognition from appropriate professional societies.

It is expected that this individual will develop a research program in one of the disciplines given above working in coordination with ongoing programs within the STAR Laboratory and, possibly, with other activities within the Stanford Center for Space and Atmospheric Studies. The successful candidate will have a strong background in experimental techniques, either in the laboratory or in the field, including the environment of space; experimental activities in either laboratory or space. The successful candidate would be regarded as good qualifications. However, close association with theoretical development in plasma physics and/or electromagnetic theory will clearly be desired. It is also expected that the individual will have a demonstrated capability for securing federal or other research grant support, or be deemed by the selection committee of being capable of securing such funds.

It is anticipated that the person chosen will devote the major part of his or her time to research activities. However, there is an opportunity for participation in academic responsibilities of Electrical Engineering Department, including, when time permits, teaching graduate and undergraduate classes, serving on various committees of the department, School of Engineering, and the University. It is expected that the person chosen will participate actively in the training of graduate students.

The Chairman of the selection committee for this position is Professor Robert A. Hellweger, Professor of Electrical Engineering, Space, Telematics, and Radioscience Laboratory, Stanford University, Stanford, CA 94305. Other members of the selection committee include Professor P.M. Banks, Professor R.N. Brueckel, Professor L.R.O. Storey, and Professor L. Tyler.

University of Southern California/Development Technologist. A candidate is sought for a tenure oriented electronics technician position. The successful candidate should be familiar with standard microprocessor based oscilloscope applications, instrumentation and have some familiarity with related deployment, maintenance, and calibration practices. FORTRAN and/or BASIC programming experience is desirable, but not mandatory. The candidate should be willing to spend 4-8 weeks at our site per year. Salary range is \$20-\$30K, depending upon experience and qualifications.

Inquiries may be made to either Dr. Alan Brinkovich or Dr. Tom Dicks, Ocean Physics Group, Department of Geological Sciences, SCI 107B, University of Southern California, Los Angeles, CA 90089-0741. (Telephone: 213-743-5478 or 213-743-8367).

The University of Southern California is an equal opportunity/affirmative action employer.

Soil Scientist/Career Federal Service. The Agricultural Research Service U. S. Salinity Laboratory, in Riverside, California, has a position available for a scientist interested in conducting theoretical research on the transport of water and dissolved substances through soils. Research should result in a set of models that describe the behavior of salts and water in soil systems. Must have knowledge of advanced soil physics, soil chemistry, and soil-water-potential relations. Salary based on qualifications and experience. GS-11212/15, \$23,469-\$36,357. Applicants must be U.S. citizens. For application procedures call Rita Millard in Beltsville, Maryland, on 301-544-5139.

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EARTH SCIENCES

The Lamont-Doherty Geological Observatory of Columbia University invites recent Ph.D. recipients or candidates for their degree in 1985 in any field of the earth sciences to apply for postdoctoral fellowships awarded for a period of one year (extendable to two years, in special instances) beginning in September 1985 with a stipend of \$26,000 per annum.

Completed applications are to be returned by January 15, 1985. Application forms may be obtained by writing to the Director, Lamont-Doherty Geological Observatory, Palisades, New York 10964. Award announcements will be made on or about February 28, 1985.

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NASA/Goddard Space Flight Center

Associate Chief Space Data & Computing Division & Head National Space Science Data Center

NASA/Goddard Space Flight Center is seeking a highly qualified individual to head the National Space Science Data Center (NSSDC). The position is for Associate Chief of the Space Data and Computing Division within the Space and Earth Sciences Directorate. The NSSDC is the principal scientific data center for NASA and operates World Data Center A for rockets and satellites. This center serves as the permanent scientific space data archive and dissemination center and is responsible for the development, management, and operation of specialized data base systems for NASA. Particular disciplinary emphasis is in solar-terrestrial physics and astrophysics. The center develops advanced data base management systems using leading technologies such as high speed mass storage retrieval systems, data base machines and expert systems. The staff consists of approximately 30 civil servants and 100 contractor personnel. The NSSDC operates an expanding computing system currently consisting of a VAX 11/780 and a MODCOMP IV/25 and will have high-speed link to an IBM 3081, a Cyber 205, and a cluster of VAX processors. NSSDC responds to world-wide requests for documentation, data services, and digital and photographic data. As Associate Chief, the incumbent will also participate in formulating the research policy and long-term direction of the Division. The position calls for both technical and managerial leadership of the organization. The appointment is at the GS-15 level, which carries a salary range of \$50,495-\$65,642.

Qualifications: Goddard is seeking a respected and visionary scientist willing to play a strong leadership role at a challenging time. Applicants should possess a Ph.D. or the equivalent experience in one of the following: a space or earth science-related discipline, computer science, or mathematics. Experience of at least 10 years, with increasing responsibility and stature, including management of a substantive technical group. Applicant should have been closely involved with advanced research utilizing scientific satellite data including data management and analysis and experienced in modern computer systems, technology, and telecommunications. In addition, applicant should have a broad understanding of the science areas in which NSSDC is involved.

Applicants: Applicants should submit a curriculum vitae, a list of publications, and Office of Personnel and Management Standard Form 171 (Personal Qualifications Statement) to Dr. Franklin D. Martin, Director of Space and Earth Sciences, Code 600, NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771. Selection will be made by the Director of Goddard Space Flight Center, with the aid of a search committee of recognized experts in appropriate disciplines. Deadline for applications is October 15, 1984.

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Illinois Department of Energy and Natural Resources/Positions Available. The Illinois Department of Energy and Natural Resources (IDNR) Water Survey Division, is developing a Hazardous Waste Research and Information Center (HWRIC). The Center is the focus of hazardous waste research information and industrial assistance in Illinois state government. Its role is to provide information and technical support to industry, the public and government officials towards a comprehensive hazardous waste management strategy for the state.

DIRECTOR-Responsibilities: The Director will be responsible for the management and implementation of Center activities and for the coordination of the research, information and technical assistance programs. The Director will report to the Chief of the Illinois State Water Survey and the HWRIC Governing Board. Initial tasks include: the evaluation of related activities at the State and Federal level, the development of efficient information clearinghouse and industrial assistance programs, supervision of research and facilities planning activities and acting as the principal spokesperson for the program.

Qualifications: The successful candidate will be an accomplished scientific professional with demonstrated experience in the management of a scientific research or service program. An advanced degree in an appropriate discipline is preferred. Salary of \$40,000 to \$55,000 per year will be commensurate with experience and qualifications.

RESEARCH PROGRAM COORDINATOR-Responsibilities: The Research Program Coordinator will be responsible for the development and implementation of Center research programs directed towards a clear definition of the extent and severity of hazardous waste problems. He/she will be well versed in the corresponding environmental and economic consequences of HW management and disposal operations and to pursue both industrial and government sponsorship of research. The Coordinator will report to the Director of the Center, will directly supervise a small staff of research professionals and direct contract research support (> \$50M) activities with internal and external agencies.

Qualifications: The successful candidate will be an experienced scientist with demonstrated research project management skills. An advanced degree (Ph.D.) in a relevant environmental discipline is preferred. The salary range starts at \$30,000 to \$45,000 per year depending upon the needs of the program.

ENGINEER/INDUSTRIAL ASSISTANCE COORDINATOR-Responsibilities: The Coordinator will be an integral part of the management team of the Center, responsible for the development of a comprehensive program of industrial and technical assistance. Initial tasks will include: establishing contact with industry and trade groups involved in HW reduction and alternative treatment programs; preparing reliable procedures for the analysis of materials flows and auditing to encourage waste reduction, product substitution, process modification and alternatives to HW handling. The Coordinator will report directly to the Director of the Center and will be expected to integrate program activities with related research and information efforts.

Qualifications: The successful candidate will be an experienced chemical process or treatment engineer, motivated towards an effective HW management strategy for Illinois' industry. He/she will have demonstrated experience in the management of waste research or service programs which address environmental and economic constraints effectively. Salary is \$40,000-\$50,000 per annum commensurate with experience and the needs of the program.

TECHNICAL INFORMATION SPECIALIST-Responsibilities: This position will aid in the development of a comprehensive hazardous waste information clearinghouse and HW Hotline in the Center. The position involves the collection and publication of materials on HW issues, as well as technical information for the use of Center research and technical assistance staff. Initial tasks include the development of a bibliographic data base on HW and the preparation of issue papers for the public and legislative on various issues related to HW management. The position is under the direct supervision of the Information Program Coordinator.

Qualifications: The successful candidate should have a B.S. degree in the data management and information transfer activities of a high level scientific group. Technical writing and communication skills are essential. A degree in library, computer science, or closely related discipline is required. The salary range is \$20,000-\$25,000 per annum, negotiable according to experience.

INFORMATION PROGRAM COORDINATOR-Responsibilities: The Coordinator will be responsible for the planning and implementation of HW information clearinghouse and data base development activities of the Center. He/she will report to the Director and actively cooperate with the staff of the research and technical assistance programs. The successful candidate will supervise the information and data management activities of the Center.

Qualifications: Familiarity and experience with bibliographic information transfer and computer-aided research needs of an advanced scientific group are essential. Microcomputer literacy would be useful. Technical writing and issue analysis experience are preferred with adequate scientific experience. Salary level for this position is \$24,000-\$28,000 per annum, negotiable according to experience.

RESEARCH SCIENTIST (2) - Responsibilities: Applicants are to fill two research positions in support of HWRIC problem assessment and problem solving research activities. Each position is under the direct supervision of the Research Program Coordinator. Initial tasks will include an assessment of the existing materials and analytical capabilities of HW generation, treatment and disposal facilities in Illinois with an emphasis on environmental and economic impacts. Industrial, economic and environmental data must be evaluated from a variety of research findings in diverse scientific research efforts in the U.S. of HW related problems towards the development of an effective waste management strategy. In-depth assessments of materials, storage, disposal and treatment practices in regional to local settings will be conducted to better assess the research facility needs of the state. This will entail the development of related data base to integrate existing regulatory and natural resource data pertaining to waste management activity in the past, present and the future.

Qualifications: It is anticipated that each candidate will have at least three years experience and an advanced degree (M.S. preferred) in a basic science (hydrology, chemistry) or engineering (civil, mechanical, environmental) discipline. Research contract involvement in hazardous waste management and cooperative participation would be useful. The successful candidates would be expected to have previous experience in scientific and engineering data base management and solid background in geology, geophysics, and the School of Petroleum and Chemical Engineering and the School of Chemical Engineering and Materials Science, both from the College of Engineering.

Applications with curriculum vitae, names and addresses of three references, and other nominations should be sent to:

Francis G. Stehl, Dean
College of Engineering
University of Oklahoma
600 Elm Street, Room 480C
Norman, OK 73019

Consideration of applications will begin January 1, 1985.

The University of Oklahoma is an Equal Opportunity/Affirmative Action Employer.

Landfilling. The successful candidate will develop materials flow estimates, self-audit and direct waste management procedures, as well as an up-to-date data base on Illinois' HW generation in cooperation with Center research and information staff.

Qualifications: Proven experience in the design and implementation of waste treatment and disposal engineering schemes are preferred. Excellent communication and writing skills are essential. An advanced degree in civil, chemical or environmental engineering, or a closely related discipline, is required. Salary range is \$35,000-\$40,000 per year, negotiable according to experience.

APPLICATIONS: Qualified applicants should submit their resumes and three letters of reference to:

Stanley A. Changnon, Jr., Chief
Illinois State Water Survey
P.O. Box 5030, Station A
Champaign, IL 61820

CLOSING DATE: November 30, 1984.

The State of Illinois is an equal opportunity/affirmative action employer.

Geophysicist/University of North Carolina. The Department of Geology invites applications for a tenure track faculty position in solid earth geophysics beginning July 1, 1985. The position holder will be at the assistant professor level, but candidates at the associate professor level will be considered. The Ph.D. is required, and post-doctoral experience is desired. Our preference is for a seismologist and/or tectonic geophysicist, who would complement current departmental activities, but any good applicant in geophysics will be considered. Faculty members are expected to conduct a viable and active research program, teach graduate and undergraduate students, and supervise theses.

Inquiries and letters of application should be sent to: Dr. Geoffrey Fries, Department of Geology 028A, University of North Carolina, Chapel Hill, NC 27514. Applications must include resume, statement of research and teaching interests, and the names of at least three references. Closing date for applications is October 19, 1984.

The University of North Carolina is an affirmative action/equal opportunity employer.

Head/Department of Geosciences. The Pennsylvania State University seeks an academic leader to serve as Professor and Head of a large department with 55 faculty members divided among three academic programs: Geochemistry-Mineralogy, Geology and Geophysics.

A doctor's degree, significant publications and high scholarly standing are required; administrative experience is highly desirable.

Applications will be accepted until October 15, 1984. Applicants should submit a letter of interest and curriculum vitae to:

Arnold Muan, Chairman
Geology Search Committee
415 Walker Building
University Park, PA 16802

The Pennsylvania State University is an equal opportunity/affirmative action employer.

Scripta Institution of Oceanography/Geoscientist. Applicants are invited for a tenure track faculty position in the general field of geoscientist and petrology, including inorganic/physical marine chemistry, marine biogeochemistry, geochemistry of sedimentary, metamorphic, and igneous rocks, fluid-rock interactions, theoretical and experimental petrology, and organic geochemistry. The position will involve graduate-level teaching and the supervision of graduate student research. The level of the appointment will depend on the applicant's qualifications. Applicants must hold Ph.D. degree and have demonstrated excellent and independent research. Associate or assistant level candidates must demonstrate a strong research record in their specialization; assistant level candidates will be expected to show evidence of their potential through publication record appropriate for their experience and letters of recommendation. Send letter of application and curriculum vitae, including description of research interest, and names of three references to: Chairman, Graduate Department, A-008, Scripta Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093. Closing date for applications is 1 November 1984.

An equal opportunity/affirmative action employer.

Academic Administrator/Assistant or Associate Research Oceanographer. The Center for Coastal Studies, Scripta Institution of Oceanography has an opening for a full-time position. 50% Academic Administrator/50% Assistant/Associate Research Oceanographer.

The Center conducts a wide variety of field, laboratory and theoretical work in waves, currents, shore processes, mechanics of nearshore sediment transport, estuarine processes, continental shelf and marginal seas research.

The successful candidate will have a Ph.D. in physical oceanography or a related science. The level of appointment will be determined by experience and level of independence in his/her field as evidenced by reviewed publication record in the scientific literature and research record. The ability to interact with a variety of people within and outside the University, particularly funding agencies, are essential. Knowledge of a broad spectrum of research areas is also essential. Some understanding of administrative issues, e.g., personnel and budgets is essential.

The Administrative portion of the position is primarily state-funded. The Research portion will be funded by the Center for 12 months to enable the candidate to later obtain contract/grant funding either separately or in cooperation with other department researchers.

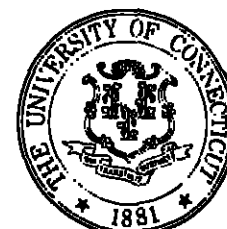
Send resumes, including areas of research interest and list of publications, with three letters of reference by 31 October 1984 to:

Dr. Douglas L. Inman, Director
Center for Coastal Studies, A-008
Scripta Institution of Oceanography
University of California-San Diego
La Jolla, CA 92093

UCSD is an Equal Opportunity/Affirmative Action Employer.

Monash University, Victoria, Australia: Department of Earth Sciences Continuing & Flexible Learning. Lectureships/Senior Lectureships in Geophysics. Commencing early 1985. One position for a scientist with research expertise in any of the following: (a) geophysics, (b) solid Earth geophysics, (c) tectonophysics, geodynamics, or exploration geophysics, and one position for a scientist with research expertise in any of the following: (a) geophysics, (b) tectonophysics, geodynamics, or exploration geophysics. Possible extension of fixed-term position to 3 years. Applicants to establish research programs in developing industry and government support employment. The successful candidate will have a Ph.D. and postgraduate research experience in geophysics, and a strong background in research and teaching. The successful candidate will have a Ph.D. and postgraduate research experience in geophysics, and a strong background in research and teaching. The successful candidate will have a Ph.D. and postgraduate research experience in geophysics, and a strong background in research and teaching.

The University of Connecticut is expanding its program in Marine Sciences and seeks qualified candidates for the following positions. All positions require a Ph.D.



DIRECTOR Marine Sciences Institute

DIRECTOR National Undersea Research Program

DIRECTOR Connecticut Sea Grant Program

Apply by November 11, 1984 to:

Alexandra Van Gelder
UNIVERSITY OF CONNECTICUT
Research Foundation
Box U-133
Storrs, CT 06268
203-486-3337.

(Search 4G119, 4G125, 4G128) AA/EOE

PHYSICAL OCEANOGRAPHER Program Manager

Science Applications International Corporation (formerly Science Applications, Inc.-SAIC), a large, employee-owned research contractor for the government and private industry, has an opening for a senior scientist with a background in physical oceanography or a closely related area. Primary responsibilities of the successful applicant will be to manage a major field measurement and data synthesis program involving principal investigators for SAIC and several leading oceanographic institutions, and to participate in business development in the areas of ocean science and engineering. Applicants should have a Ph.D. and at least six years post-doctorate experience. Expected salary level is commensurate with qualifications and experience.

For more information, please contact:
Dr. Paul Debrule
Science Applications International Corporation
P.O. Box 509
Newport, Rhode Island 02840
Telephone: (401) 847-4210

SAIC is an equal opportunity employer.

A MS or PhD is required in Earth Science, Chemistry, Physics or Engineering. Minimum salary will be \$18,000/12 months with an MS. Send letter of application, transcripts, resume, and names and addresses of three references by September 15 to Dr. John W. Vail, Department of Geology & Geophysics, Weeks Hall, University of Wisconsin, Madison, WI 53706.

An equal opportunity employer.

University of Utah: Structural Geology/Tectonics. The Department of Geology and Geophysics at the University of Utah seeks applications for a tenure track position in structural geology, tectonics or tectonophysics. It is anticipated that this position will be held at the assistant professor level, but applicants with more senior persons will be considered. The position requires a Ph.D. with emphasis in structural geology, regional tectonics or tectonophysics. The new faculty member will have the opportunity to teach in the area of his or her specialty and may also be assigned introductory level courses. The successful candidate will be expected to establish a vigorous research program involving graduate students. The person who fills this position will join an active program in structural geology and tectonics that includes both field projects and integrated geology/geophysics and mechanics/ fluid chemistry studies of structures in the western Cordillera. There is an excellent opportunity to collaborate with other faculty in structural geology, sedimentology, geophysics, geochemistry and petrology. A vita, copies of publications, names of three persons that may provide references, and a letter outlining the candidate's research and teaching interests should be sent to Dr. William P. Nash, Chairman, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112-1185. Deadline for receipt of applications is December 31, 1984 with the appointment starting in September 1985.

The University of Utah is an equal opportunity/affirmative action employer.

MARINE CHEMIST

The Chemistry Department of the Woods Hole Oceanographic Institution plans to add a tenure track appointment as Assistant Scientist and invites applications from researchers with interest in the field of Marine Chemistry. Applicants should have a Ph.D. and preferably post-doctoral experience with a demonstrated interest in natural systems and strong basic physical, organic or analytical chemistry background to study chemical processes in marine systems. Experience with techniques in reaction kinetics and mass spectrometry would be particularly valuable. Interested candidates should send resume, transcript, reprints and names of potential referees, to:

Personnel Manager
Box 54 P



WOODS HOLE
OCEANOGRAPHIC
INSTITUTION
Woods Hole, MA 02543
An equal opportunity employer M/F/H

Research Geophysicist. The U.S. Geological Survey (USGS), Office of Earthquakes, Volcanoes, and Engineering, Branch of Seismology is soliciting interest from exceptionally well-qualified persons with either a record of research or strong potential for research in one or more areas of Branch activity. The Branch of Seismology conducts fundamental research in the fields of earthquake prediction, network seismicity, crustal structure and volcano seismology. The Branch is particularly interested in a geophysicist with expertise in the field of seismology.

All interested persons should submit a detailed resume of education, experience, summary of interests and research intentions, and the appropriate salary level commensurate with experience by 5 October 1984 to:

William Ellsworth
U.S. Geological Survey
Branch of Seismology
345 Middlefield Road
Menlo Park, CA 94025

Should a position become available in the Branch, you will be notified of the competitive Federal employment application requirements.

The U.S. Geological Survey is an Affirmative Action/Equal Opportunity Employer.

Physical Oceanographer/Coastal Engineer. Evans-Hamilton Inc., an oceanographic consulting firm in Washington, D.C. area, has an opening for a physical oceanographer/coastal engineer at the MS or PhD level. Emphasis is in numerical modeling of wind, wave, tides, and currents in estuary and on the shelf and also on solving related coastal engineering problems. Some experience in data acquisition and/or analysis is desirable. Salary is open. Company provides medical and profit sharing plans. Send resume to Douglas L. Evans, Evans-Hamilton Inc., 554 Hungerford Drive, Rockville, MD 20850 or call 301-762-8070.

Department Head of Plant Sciences/University of Nevada Reno. The College of Agriculture, University of Nevada Reno, is seeking applicants for this twelve-month tenure track position. The Department has numerous faculty and conducts teaching, research and extension programs in the areas of agronomy, horticulture and integrated pest management. A Ph.D. in a plant science related discipline and evidence of administrative and leadership abilities are required. Closing date for applications is October 15, 1984. The position is available January 1, 1985. Contact: Dr. Edward Miller, Chairman, College of Agriculture, UNR, Reno, NV 89557-0004, 702-784-4061.

The University of Nevada Reno is an equal opportunity employer.

Northwestern University/Department of Geological Sciences. Applications are invited for a tenure track position at the assistant professor level from persons who will complement one of the existing departmental research programs in structural geology, tectonics, petrology, or sedimentary geology. Applicants must hold the Ph.D. degree by the time of appointment and demonstrate excellence in research or strong potential for independent research in one of these fields. In addition to having a strong research orientation the position will involve teaching at the undergraduate and graduate levels and the supervision of graduate student research. Current departmental facilities include VAX 11/780 computer, fully automated JEOL 733 Microprobe/SEM and high pressure and geochronological laboratories.

Letters of application should be accompanied by a resume that includes a description of research interests and accomplishments and teaching experience, a list of publications, and the names of at least three references. Send to: N.O. Schlanger, Chairman, Department of Geological Sciences, Northwestern University, Evanston, Illinois 60201. Closing date for applications is November 1st, 1984. We expect to fill the position for the fall of 1985.

Northwestern University is an equal opportunity/affirmative action employer.

JPL/Meteorologist. The Jet Propulsion Laboratory, California Institute of Technology, invites applications for a full-time Meteorologist to work in the field of satellite meteorology. Candidates must possess a MS Degree in Meteorology and will address topics related to the interpretation and verification of the satellite scatterometer data. The position requires knowledge of mesoscale meteorology, time series analysis, and FORTRAN programming. Please submit resume to Professional Staffing, Department M-40.

Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109
Equal Opportunity Employer M/F.

POSITIONS WANTED

Teaching and/or Research - Geology, Paleontology, Geophysics, Mining and Petroleum Engineering. Extensive practical and teaching experience in the US and abroad. Specialties in resource exploration and development - multidisciplinary with them Persian and Turkish. Salary and rank negotiable. Reply to: 4085, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C. 20008.

Meetings

Announcements

Extraordinary Floods

October 14-18, 1985 U.S.-China Bilateral Symposium on the Analysis of Extraordinary Flood Events, Nanjing, China. Sponsors: USGS, Bureau of Hydrology of the Ministry of Water Resources, and Earth Power of the People's Republic of China. (Marshall E. Moss, Chief, Surface Water Branch, U.S. Geological Survey, 415 National Center, Reston, VA 22092; tel.: 703-860-0837.)

One-page abstracts should be submitted by October 1, 1984.

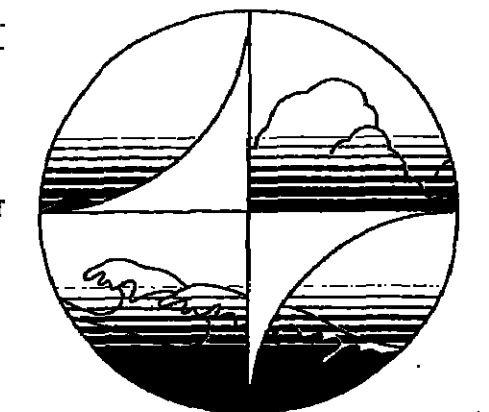
The theme of this bilateral symposium is the analysis of extraordinary floods, or floods that are perceived to have a recurrence interval in excess of 50 years. The following topics will be addressed: the detection of historical floods and the uncertainties of their peak discharges and times of occurrence; frequency analysis of annual flood peaks when extraordinary floods are present in systematically gaged flood records and when historic floods are detected; the use of storm data in determining design storms and design floods; multivariate analysis of flood peaks and flood volumes in the presence of historic floods and historic storms; detection of trends in flood occurrences in the presence of extraordinary floods; critique of U.S. and PRC guidelines for flood analysis that treat extraordinary floods; comparative case studies of U.S. and PRC flood analyses (three case studies each of U.S. and Chinese design-flood experience). For each of the topics, particular emphasis will be placed on the effects of errors contained in the determination of flood magnitudes. Each of the fifty symposium attendees (equally divided between the two sponsoring nations) will be expected to contribute a paper under one of these topics.

The symposium will be followed by a 6 day study tour of sites where historic floods have been documented in China.

Continental Crust

Oct. 24-26, 1984 Nature of the Lower Continental Crust. London, England. Sponsors: Geological Society, Royal Astronomical Society, Wigner Foundation, (Geological Society, Burlington House, Piccadilly, London W1V 0JU, England.)

This meeting brings together geophysicists, structural geologists, metamorphic petrologists, and geochemists to review current research on the lower continental crust.



Second Circular September 1984

Call for Papers IAMAP/IAPSO Joint Assembly August 5-16, 1985 Honolulu, Hawaii

Sponsors

The IAMAP/IAPSO Joint Assembly is sponsored by the International Association of Meteorology and Atmospheric Physics (IAMAP) and the International Association for the Physical Sciences of the Ocean (IAPSO) of the International Union of Geodesy and Geophysics (IUGG).

Meetings (cont. on p. 696)

MARINE GEOTHERMAL RESEARCH

Applications are invited for a staff position in a geothermal research group in the Department of Geology and Geophysics, Woods Hole Oceanographic Institution. Ongoing research includes field programs and modelling of oceanic hot spots, hydrothermal circulation, continental rifting, and development of passive continental margins. Opportunities for participation in the MIT - WHOI Joint education program are available.

Qualifications include a Ph.D. or equivalent in Geophysics or Earth Sciences, with some experience in marine geothermal research. An orientation to field programs and experimentation is preferred, although theoretical/analytical expertise is also desirable. A successful candidate is expected to develop his/her own research programs and support, although some support is available from ongoing research programs over the first year. Salary dependent on background and experience.

Send resumes and names of at least 3 professional references to:

Personnel Manager
Box 54 P



WOODS HOLE OCEANOGRAPHIC INSTITUTION

Woods Hole, MA 02543
An equal opportunity employer M/F/H

RAYMOND E. SULLIVAN Fellowships in Natural Resources

For graduate study in:
Forest Management Science
Resource Ecology
Water and Air Resources
Resource Economics and Policy

Yearly stipends up to \$7,000 plus research awards/scholarships, available for Ph.D. candidates

Write or call for information and applications
Director of Admissions and Financial Aid
School of Forestry and Environmental Studies
Department EA
Duke University
Durham, North Carolina 27706
(919) 684-2115

DUKE UNIVERSITY

Hydrologist/Texas A&M University. The Department of Geology and Center for Engineering Geosciences have a tenure track opening, preferably assistant professor level, for which the first search will be for a creative individual working in applied geological hydrology.

The successful applicant will be expected to develop teaching and research recognition at a national level. The position is available beginning September 1, 1984 and will be held open until filled. Applicants should submit a vita including names of references to M.T. Gilbert, Department of Geology, Texas A&M University, College Station, TX 77843.

Texas A&M University is an affirmative action/equal opportunity employer.

College of Geosciences/University of Oklahoma. Applications and nominations are invited for the position of Director of the School of Geology and Geophysics. The Director is expected to have a Ph.D. or equivalent, a strong, ongoing research program and administrative experience. Industrial experience helpful; field of geological specialization open; to begin July 1, 1985; salary to be negotiated. In 1984, the School will move into the new 300,000 sq. ft. Energy Center along with other elements of the College of Geosciences, the Oklahoma Geology Survey, and the School of Petroleum and Chemical Engineering and the School of Chemical Engineering and Materials Science, both from the College of Engineering.

Applications with curriculum vitae, names and addresses of three references, and other nominations should be sent to:

Francis G. Stehl, Dean
College of Geosciences
University of Oklahoma
600 Elm Street, Room 480C
Norman, OK 73019

Consideration of applications will begin January 1, 1985.

The University of Oklahoma is an Equal Opportunity/Affirmative Action Employer.

Meetings (cont. from p. 693)

Cosponsors

We are pleased to have the American Geophysical Union (AGU) and the American Meteorological Society (AMS) as our hosts, and thereby as the organizers of the Assembly. We also hope to confirm the cosponsorship of the Optical Society of America (OSA) for a symposium relevant to their interests.

This Assembly continues the excellent cooperation that IAPAP enjoys with the World Meteorological Organization (WMO), which cosponsors the overall Assembly as well as certain symposia of particular interest to WMO. On the occasion of this Assembly, it is our pleasure to join WMO in the organization of the Fourth WMO Scientific Conference on Weather Modification.

We are looking forward to cosponsorship of the Nowcasting IIa symposium by the European Space Agency (ESA). Cosponsorship of the European Geophysical Society (EGS) is also being sought for certain symposia.

Since this is a IAPAP/IAPSO Joint Assembly, it seems only appropriate that the Scientific Committee on Ocean Research (SCOR) would be a cosponsor involved in the development of the scientific program from its earliest stages. We are also in the process of requesting cosponsorship from other international Council of Scientific Unions (ICSU) bodies for symposia relevant to their interests; these include the Committee on Space Research (COSPAR), the Scientific Committee on Antarctic Research (SCAR), and the United Nations Educational and Cultural Organization (UNESCO).

Introduction

IAPAP and IAPSO last joined forces in an off-year joint scientific assembly in January 1974 in Melbourne, Australia. The rapidly evolving World Climate Research Programme (WCRP) included major programs in both atmospheric and oceanic circulations and forcings, and provided strong motivation to join forces again. Large-scale atmospheric and oceanic processes, and their interactions, form the core of the WCRP. The IAPAP/IAPSO Joint Assembly will provide an opportunity to assess the scientific status of these processes so crucial to climate, its variability, and its changes.

The site for the meeting, Honolulu, Hawaii, was selected for the pleasant atmosphere and climate, and the ease in accessibility from around the world.

Housing and Registration Information

Living accommodations for participants are available in the same facility as the Assembly, the Hilton Hawaiian Village. Rooms in this facility are large and contain two beds. The room rates range from US \$74 to \$104; thus, participants have the opportunity to halve their rooming costs by sharing a room with a colleague.

Specific information regarding accommodations and registration will be published in the Third Circular, in January 1985.

Travel Funds

There are limited funds at our disposal for use in assisting participants to attend the Assembly; moreover, spread over all the symposia, there is the capability to help only a very limited number of colleagues for each symposium. Participants who need some financial assistance should address their request to the respective convenor who will in turn make a recommendation to the relevant Secretariat of IAPSO or IAPAP.

General

All scientists are invited to participate in the Assembly. Those wishing to present a paper should submit an abstract. Deadline for receipt of abstracts—March 15, 1985. This is a firm deadline.

Abstract Preparation

Authors are urged to take the utmost care in preparation of their abstracts since there will be no opportunity for correction. The program and abstract book will be prepared by photographing the abstracts exactly as they are received with a 50% reduction for the printed abstract volume. Please use the model abstract to prepare the final version.

The abstract page is divided into two parts: (a) the abstract itself and (b) the submittal information. Follow the instructions for both carefully.

a. The abstract copy must be of letter quality type. Do not exceed the maximum dimensions specified for the abstract (11.8 cm x 18 cm) or the abstract will be trimmed to conform to this size.

b. The second part of the abstract page involves the submittal information which must accompany the abstract. Authors must include the following (numbers refer to the items in submittal block on sample abstract): 1. title of meeting (IAPAP/IAPSO Joint Assembly);

2. corresponding author's address (give complete address and phone number of author

Sample Abstract (See explanation)

11.8 cm

NOTE: There are no special forms distributed for typing abstracts. You may trace this form in nonreproducible ink. Please leave at least 4 cm between top edge of paper and abstract title. Type abstract as close as possible to left edge of paper.

INSTRUCTIONS ON PREPARATION OF TYPEWRITTEN COPY

FIRST AUTHOR (School of Oceanography,
Hydro University, Watertown, MA 02172)
SECOND AUTHOR and ANY AUTHOR (Both at: NCAR,
P.O. Box 3000, Boulder, CO 80307)

Follow these guidelines:

Type title in capital and lower case letters except where all capitals are standard; underscore entire title.

Leave one line blank after title.

Type names of authors in all capital letters, with affiliation and address in capital and lower case letters. Do not leave blank lines between authors.

Underscore the name of the author who will present paper.

Leave one blank line after author block.

Indent paragraphs two spaces. Do not leave blank lines between paragraphs.

Neatly drawn in symbols, Greek letters or other camera reproducible copy is acceptable.

Abstracts must be submitted in the English language, the official language.

1. IAPAP/IAPSO Joint Assembly
2. John E. Scott
NCAR
Stop 999
P.O. Box 3000
Boulder, CO 80307
3. JS-1

18 cm

ABSTRACT DEADLINE
MARCH 15, 1985

Mail Original
and two copies to:

Joint Assembly Meeting
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

to whom all correspondence, acknowledgement, and acceptance should be sent).

3. Indicate symposium code (example JS-1).

Submission of Abstracts

The ORIGINAL plus two copies of the abstract, prepared in the format specified above, should be mailed to Joint Assembly Meeting, American Geophysical Union, 2000 Florida Ave. N.W., Washington, DC 20009 USA by the March 15 abstract deadline date. AGU will forward copies of abstracts to the appropriate convenors.

The deadline for receipt of abstracts is firm! Those abstracts not received by the deadline may possibly be included by the convenor in a reserve program, but it is unlikely it will be possible to include them in the program or abstract book. Abstracts containing material outside the scope of IAPAP/IAPSO activities may not be considered. Authors may submit more than one abstract; however, they may not submit the same abstract to more than one symposium. Invited speakers are also required to submit an abstract.

Submission of an abstract is presumed to carry with it permission for AGU to reproduce the abstract in the program and any reports related to this meeting. It is also presumed to permit the free copying of those abstracts; authors are not requested to transfer copyright. Copyright, where it exists, will be reserved by the authors.

Provisional Schedule

This circular includes a provisional schedule for all symposia. The schedule has been arranged to keep conflicts to a minimum. However, some topical conflicts will inevitably remain.

No sessions will be scheduled during the first session of each Joint Symposium or during opening and closing Plenaries. Information on business sessions will be included in the final schedule, to be distributed with the program and abstract book.

Joint Symposia

JS-1 The Southern Oscillation and El Niño

Lead: IAPSO; Cosponsor: IAPAP (CCL, CDM).
Convenor: G. Philander (IAPSO), GFDL/NOAA, Princeton University, P.O. Box 308, Princeton, NJ 08542, USA.
Co-Convenor: M. Blackmon (IAPAP/CCL), ASP/NCAR, P.O. Box 3000, Boulder, CO, 80307, USA.

Papers that describe recent results concerning the following aspects of El Niño and the Southern Oscillation (ENSO) are invited: Observational (oceanographic and meteorological) studies of complete Southern Oscillation cycles, and of the development and decay of warm events; Indian and Atlantic Ocean anomalies associated with ENSO; teleconnections to higher latitudes, north and south; empirical prediction of ENSO; simulation of atmospheric variability associated with anomalous sea surface temperatures in the tropics; simulation of the oceanic variability associated with the Southern Oscillation; air-sea interaction in the tropics.

JS-2 CO₂ in the Ocean/Atmosphere System

Lead: IAPAP (CAGCP, CCL); Cosponsor: IAPSO.
Convenor: D. Raynaud (IAPAP/CCL), Laboratoire de Glaciologie et Géophysique de l'Environnement, Rue des Cloîtres 2, B.P. 96, F-38031, Grenoble, Cedex, France.

Co-Convenor: Taro Takahashi (IAPSO), Lamont-Doherty Geological Observatory, Palisades, NY 10964, USA.
The role of the oceans as source and sink of atmospheric CO₂ will be the central theme. Questions to be addressed include the effects of oceanic chemistry, biology and circulation on the atmospheric CO₂, the influence of atmospheric circulation on the CO₂ exchange at the ocean-atmosphere interface, the uptake of anthropogenic CO₂ by the oceans and the role of the ocean in interpreting the past records of the atmospheric CO₂.

JS-3 Monitoring the Ocean/Atmosphere System—New Techniques

Lead: IAPSO; Cosponsor: IAPAP (RC).
Convenor: M. Hall (IAPSO), NOAA, Code EM-6, 6010 Executive Boulevard, Rockville, MD 20852, USA.

Co-Convenor: J. Harries (IAPAP/RC), Science and Engineering Research Council, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11 0QX, United Kingdom.

The symposium will address emerging observational techniques which hold promise for monitoring of oceanic and atmospheric phenomena on the scales needed for global climate research. Session papers will include satellite instrumentation as well as in situ developments which offer new observational capabilities or unique new ways of making conventional observations. Treatment of air-sea fluxes with combinations of heat and salt in situ instrumentation is of particular interest. The emphasis will be on techniques which offer efficiencies through their scale of coverage, through inherent integrating properties

(if appropriate for climate research), or through their remote sampling characteristics. Contributions focused on the needs of emerging programs within the World Climate Research Program (WCRP) will be sought, but discussion of new techniques with broader application is also encouraged.

JS-4 Modeling the Global Ocean/Atmosphere Climate System

Lead: IAPAP (CCL, CDM, CPM); Cosponsor: IAPSO.
Convenor: W. Lawrence Gates (IAPAP/CCL), Department of Atmospheric Sciences, Oregon State University, Corvallis, OR 97331, USA.

Co-Convenor: Claude Frankignoul (IAPSO), Laboratoire de physique et chimie marines, Université Pierre et Marie Curie, 4, Place Jussieu, Tour 24-25, F-75230, Paris Cedex 05, France.

This symposium will focus on the design, calibration, and application of both simplified dynamical models and comprehensive models (GCMs) for the coupled global ocean-atmosphere climate system. Papers are invited for sessions on: the parameterization of physical processes in the coupled system, such as the heat and momentum fluxes in the oceanic and atmospheric surface boundary layers, and the treatment of sea ice; the sensitivity of the climate in oceanic and/or atmospheric models to variations in surface forcing, and the climate's predictability; the simulation and analysis of seasonal, interannual and decadal variations in both the ocean and atmosphere, including the surface heat budget in both low and high latitudes, the monsoons and low-high latitude teleconnections; the use of coupled ocean/atmosphere models in estimating the climate's response to both natural and anthropogenic factors such as aerosol/dust loading and CO₂ concentration.

JS-5 Heat Transports: Heat and Water Budgets

Lead: IAPSO; Cosponsor(s): IAPAP (CCL, CDM, RC).
Convenor: Fred Dobson (IAPSO), Ocean Circulation Division, Atlantic Oceanographic Laboratory, Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, Nova Scotia, B2Y 4A2 Canada.

Co-Convenor: Tomio Asai (IAPAP/CCL, CDM), Ocean Research Institute, University of Tokyo, 1-15-1, Minamidai, Nakano-ku, Tokyo 164, Japan.

This symposium will have as its central theme the elucidation of mechanisms by which meridional transports of heat and salt/moisture in the ocean and atmosphere are accomplished on a global scale. Theoretical, numerical and experimental contributions are

invited which investigate the physical processes involved, the size of the transport, and their distribution in space and time. Of particular interest will be attempts by meteorologists to obtain realistic estimates of the atmospheric divergences of the fluxes of heat and moisture over oceans and continents, by air-sea interaction specialists to improve (and prove) the accuracy of oceanic averages of the surface fluxes, by oceanographers to investigate the partitioning of the oceanic fluxes of heat and salt between the gyral and overturning circulations, and by numerical modelers to allow for interactive coupling of ocean and atmosphere.

JS-6 Monsoon Circulations in Ocean and Atmosphere

Lead: IAPAP (CCL, CDM); Cosponsor: IAPSO.

Convenor: C. P. Chang (IAPAP/CDM), Department of Meteorology, Naval Postgraduate School, Code 68, Monterey, CA 93943, USA.

Co-Convenor: Michele Fieux (IAPSO), Laboratoire d'océanographie physique, 42 rue Guvier, F-75231 Paris Cedex, France.

This symposium will cover all scales of atmospheric and oceanic motions that are related to the monsoons. For the atmosphere it will include the summer and winter monsoons of Asia, Africa and Australia. It will take into account observational, theoretical, and numerical studies of monsoon structure, development, variability, dynamics, interregional interactions and interactions with other motion systems.

For the ocean it will include all the Indian Ocean processes related to the monsoons, observational, theoretical, and numerical studies of the structure and variability of the ocean circulation, and thermal content, studies on the coupling between the monsoons and the ocean.

PS Precipitation Session on Meteorology and Physical Oceanography

Cosponsors: IAPSO and IAPAP.
Convenors: Eugene LaFond (IAPSO) LaFond Oceanic Consultants, P.O. Box 7325, San Diego, CA 92107, USA, and Stan Ruttenberg (IAPAP) UCAR Projects Office, P.O. Box 3000, Boulder, CO 80307, USA.

Many types of papers require the ability to display much graphical, alpha-numeric, or pictorial material, too much to show using slides. Furthermore, it is often better in some cases to be able to have one-on-one conversations with colleagues using these display materials. For these kinds of reasons, a Precipitation Session will be held during the Assembly for those papers for which such presentations are the most effective way to exchange information.

Contributed papers covering any aspect of physical oceanography and meteorology are welcome. They will be arranged into unifying topics by the convenors. The authors will give a three to four minute *precis* talk and will display his/her research on a poster board. In the oral presentation the author can use up to three slides, but there will be no questions following the presentation. Later, the author must stand by his/her poster for a specified half-day to give a detailed explanation and answer questions regarding his/her paper.

Information regarding preparation of posters, including the size of the poster board, will be supplied upon receipt of the abstract. The final schedule for oral presentation and half-day question and answer period will be forwarded to authors by the convenors in May 1985.

IAPSO Symposia

IAPSO Program Committee: K. Wyrtki (USA); K. Hasunuma (Japan); H. Charnock (UK); D. Halpern (USA); A. S. Sarkisyan (USSR); J. D. Woods (FRG).

O-1 Formation of the Main Ocean Thermocline

Convenor: Juergen Willebrand, Institut für Meereskunde, Düsternbrooker Weg 90, D-2300 Kiel 1, Federal Republic of Germany.
Co-Convenor: James Luyten, Woods Hole Oceanographic Institute, Wood Hole, MA 02543, USA.

This symposium will offer a forum for the discussion of current research into the processes which maintain and control the formation of the main thermocline. Questions of interest are among others: to what extent are the budgets of vorticity heat and salt (and other tracers) controlled by advective ventilation from the surface as compared to mixing; what are the influences of western boundary currents on the flow structure in the interior of the gyre; and what is the role of seasonal and interannual fluctuations in maintaining the thermocline. Papers are encouraged which deal with theoretical investigations, including those from numerical circulation models, as well as observational studies pertinent to these topics.

O-2 Low Frequency Dynamics in Mid-Latitudes

Convenor: Robert Haney, Department of Meteorology, Naval Postgraduate School, Monterey, CA 93940, USA.
Co-Convenor: Jens Meincke, Institut für Meereskunde, Düsternbrooker Weg 20, D-2300 Kiel 1, Federal Republic of Germany.

This symposium will cover the whole spectrum of low frequency variability in the mid-latitudes, including both oceanic and atmospheric phenomena.

Convenor: David E. Cartwright, IOS, Bldg. Oceanography, Birkenhead L43 7RA, United Kingdom.
Co-Convenor: Johann Lutjeharms, National Research Institute of Oceanography, CSIR, P.O. Box 320, 7600 Stellenbosch, South Africa.

This symposium will cover the whole spec-

PROVISIONAL SCHEDULE

First Week

	Monday August 6	Tuesday August 7	Wednesday August 8	Thursday August 9	Friday August 10	Saturday August 11
AM	Opening Ceremony	JS-1 Southern Oscillation and El Niño	M-1 Atmospheric Chemistry and Aerosols	JS-3 Monitoring the Ocean/Atmosphere System—New Techniques	JS-4 Modeling the Global Ocean/Atmosphere Climate System	JS-4 Modeling the Global Ocean/Atmosphere Climate System—Continuation Presentations
	IAPAP Opening Business Plenary	PS Precipitation Session on Meteorology and Physical Oceanography	M-3 Clouds and Radiation	PS Precipitation Session on Meteorology and Physical Oceanography	M-3 Clouds and Radiation	
	IAPSO Opening Business Plenary	M-13 Variability of Aerosol Optical Properties	M-8 Weather Forecasting in the Tropics	M-3 Clouds and Radiation	M-2 Long-Range Transport and Distribution of Trace Substances in Remote Regions	
		M-4 Nowcasting IIa	Special Session on the World Ocean Circulation Experiment	M-2 Long-Range Transport and Distribution of Trace Substances in Remote Regions	M-3 Planetary Boundary Layer Physics	
		M-14 Climate Effects of Nuclear War		O-4 Variations of Sea Level	O-1 Formation of the Main Ocean Thermocline	
PM	JS-1 Southern Oscillation and El Niño	JS-1 Southern Oscillation and El Niño	JS-3 Monitoring the Ocean/Atmosphere System—New Techniques	JS-4 Modeling the Global Ocean/Atmosphere Climate System	JS-4 Modeling the Global Ocean/Atmosphere Climate System	JS-4 Modeling the Global Ocean/Atmosphere Climate System
	M-13 Variability of Aerosol Optical Properties	M-13 Variability of Aerosol Optical Properties	M-1 Atmospheric Chemistry and Climate	M-3 Clouds and Radiation	M-3 Clouds and Radiation	
	O-5 Physical and Chemical Structure of the Ocean	M-14 Climate Effects of Nuclear War	M-8 Weather Forecasting in the Tropics	O-1 Formation of the Main Ocean Thermocline	M-2 Long-Range Transport and Distribution of Trace Substances in Remote Regions	
		O-5 Physical and Chemical Structure of the Ocean	O-4 Variations of Sea Level		O-1 Formation of the Main Ocean Thermocline	
EVE	M-13 (Overrun)		M-1 (Overrun)	M-3 (Overrun)		
	O-5 (Overrun)		M-3 (Overrun)	M-2 (Overrun)		
			O-4 (Overrun)	O-1 (Overrun)		

Second Week

	Sunday August 12	Monday August 13	Tuesday August 14	Wednesday August 15	Thursday August 16	Friday August 17
AM	WMO Fourth WMO Scientific Conference on Weather Modification	JS-9 CO ₂ in the Ocean/Atmosphere System	JS-2 CO ₂ in the Ocean/Atmosphere System	JS-5 Heat Transports: Heat and Water Budgets	JS-6 Monsoon Circulations in Ocean and Atmosphere	JS-6 Monsoon Circulations in Ocean and Atmosphere
		PS Precipitation Session on Meteorology and Physical Oceanography	WMO Fourth WMO Scientific Conference on Weather Modification	PS Precipitation Session on Meteorology and Physical Oceanography	M-7 Convective Processes and their Feedbacks onto the Large-Scale Motion	O-3 Dynamics of Mixed Layer
		WMO Fourth WMO Scientific Conference on Weather Modification	WMO Fourth WMO Scientific Conference on Weather Modification	M-9 Role of Aerosols in Aerosol Interactions in Mesoscale Development	M-11 Remote Sensing over the Polar Regions	
		M-10 Clouds in Planetary Atmosphere	M-12 Polar and Mid-Latitude Weather Systems	M-6 Role of Aerosols in Aerosol Interactions in Mesoscale Development	O-3 Dynamics of Mixed Layer	
		M-12 Polar and Mid-Latitude Weather Systems	M-9 Comparative Climatology of Terrestrial Planets	M-11 Remote Sensing over the Polar Regions		
		O-4 Dynamics and Thermodynamics of the Equatorial Ocean	O-6 Dynamics and Thermodynamics of the Equatorial Ocean	O-2 Low Frequency Dynamics in Mid-Latitudes		
PM	WMO Fourth WMO Scientific Conference on Weather Modification	JS-2 CO ₂ in the Ocean/Atmosphere System	JS-3 Heat Transports: Heat and Water Budgets	JS-5 Heat Transports: Heat and Water Budgets	JS-6 Monsoon Circulations in Ocean and Atmosphere	IAPAP Closing Business Plenary
		WMO Fourth WMO Scientific Conference on Weather Modification	WMO Fourth WMO Scientific Conference on Weather Modification	M-6 Role of Aerosols in Aerosol Interactions in Mesoscale Development	M-7 Convective Processes and their Feedbacks onto the Large-Scale Motion	IAPAP Closing Business Plenary
		M-10 Clouds in Planetary Atmosphere	M-9 Comparative Climatology of Terrestrial Planets	M-11 Remote Sensing over the Polar Regions	M-13 Tracing Large-Scale Motion over the Ocean in Measurements of Atmospheric Emissions	
		M-12 Polar and Mid-Latitude Weather Systems	M-6 Role of Aerosols in Aerosol Interactions in Mesoscale Development	O-2 Low Frequency Dynamics in Mid-Latitudes	O-3 Dynamics of Mixed Layer	
		O-4 Dynamics and Thermodynamics of the Equatorial Ocean	O-6 Dynamics and Thermodynamics of the Equatorial Ocean			
EVE	WMO (Overrun)	M-10 (Overrun)	JS-9 (Overrun)	JS-5 (Overrun)	M-7 (Overrun)	
	M-10 (Overrun)	M-12 (Overrun)	M-9 (Overrun)	O-2 (Overrun)	O-3 (Overrun)	

Time-table
AM 0830-1200
PM 1300-1700
EVE 1730-1900

Sessions will be focused on presenting a coherent dynamical description of mid-latitude ocean variability having timescales of a few days to a few years. Specific topics include, but are not limited to, the geographical distribution of synoptic and planetary scale variability in the ocean; optimal sampling strategies for mapping low frequency oceanic motion; the role of local and remote generating mechanisms; coastal, equatorial, and bathymetric influences; the interaction between eddies and the mean flow between the mixed layer and the main thermocline. Especially encouraged are observational, theoretical, and numerical modeling studies which offer dynamical interpretations of observed low frequency motions in mid-latitudes.

O-3 Dynamics of the Mixed Layer

Convenor: Raymond T. Pollard, Institute of Oceanographic Sciences, Brook Road, Wormley, Goldalming, Surrey, GU8 5UB, United Kingdom.
Co-Convenor: Ian S. F. Jones, Australian Navy Research Laboratory, P.O. Box 706, Darlington, New South Wales 2010, Australia.

Parameterizations of mixed layer dynamics on all time and space scales remain weak for climatic forecasting. The session will therefore focus on observations and model simulations which give new insight into the physical processes which affect upper ocean structure, their parameterization, and regional variability. Some emphasis will be placed on winter mixed layer dynamics and the structure of the layer immediately below the mixed layer which may only occasionally be modified by surface forcing.

O-4 Variations of Sea Level

Convenor: David E. Cartwright, IOS, Bldg. Oceanography, Birkenhead L43 7RA, United Kingdom.
Co-Convenor: Johann Lutjeharms, National Research Institute of Oceanography, CSIR, P.O. Box 320, 7600 Stellenbosch, South Africa.

This symposium will cover the whole spec-

trum from sub-tidal variations on continental shelves, through annual and interannual variations in tropical oceans, to decade- and longer-scale global trends relative to land level. Emphasis will be on the interpretation of sea level in terms of ocean dynamics and climate change. Contributions on modern tide-gauge networks, satellite altimetry and other techniques of space geodesy will also be welcome.

O-5 Physical and Chemical Structure of the Ocean

Convenor: H. Göte Ostlund, School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Causeway, Miami, FL 33149, USA.

Co-Convenor: Wolfgang Roether, Institut für Umweltphysik, Universität Heidelberg, IM, Neuenheimer Feld 366, D-6900 Heidelberg, Federal Republic of Germany.

The symposium will deal with research that applies the combination of chemical and physical data sets and concepts to the study of oceanic processes on medium and large scales in time and space. Included are studies utilizing both steady-state and transient tracers applied to mixing and transport processes in the oceans, modeling of physical and chemical processes, and implications on climate and bio-geochemistry. Paleoclimatic studies involving ocean chemistry and physics could also be reported here.

O-6 Dynamics and Thermodynamics of the Equatorial Ocean

Convenor: Jacques Merle, Office de la Recherche de Scientifique et Technique Outre-Mer (ORSTOM), 24 Rue Bayard, F-75008 Paris, France.

Co-Convenor: Guan Binxian, Institute of Oceanology, Academia Sinica, 7 Nan Hai Road, Qingdao, People's Republic of China.

This symposium will focus on the physical mechanisms that determine the motion field and the thermal state of the equatorial oceans. Questions of interest are, among others, the extent of the coupling of dynamical and thermodynamical processes, the processes controlling the regions of largest variability, and the coupling with the atmosphere. Partic-

ular emphasis will be given to time dependent processes in the low frequency domain. Studies comparing the similarities and differences among the three oceans are encouraged. Equal emphasis will be given to observational, analytical, theoretical and numerical modeling studies.

WOCE Special Session of the World Ocean Circulation Experiment

Convenor: Francis Bretherton, AAP/NCAR, P.O. Box 9000, Boulder, CO 80307, USA.

A special session on the World Ocean Circulation Experiment is being organized. Six invited speakers will report on various aspects of this experiment.

IAPAP Symposia

M-1 Atmospheric Chemistry and Climate

Cosponsoring Commissions: CAGCP, CCL, Convenors: Paul Crutzen (CAGCP), Max-Planck-Institut für Chemie, Postfach 9060, D-6500 Mainz, Federal Republic of Germany, and J. Hansen (CCL), GISS/NOAA, 2880 Broadway, New York, NY 10024, USA.

This symposium will cover two interphase areas between atmospheric chemistry and climate variability: 1) Climate relevance of historical and predicted chemical composition changes of both gases and aerosol in the atmosphere, and; 2) Climate causes of atmospheric composition changes.

M-2 Long-Range Transport and Distribution of Trace Substances in Remote Regions

Cosponsoring Commissions: CAGCP, CPM, Convenors: R. Delmas (CPM), Laboratoire de Glaciologie de CNRS, 2, rue des Cloîtres, F-38031 Grenoble Cedex, France, and H. Rodhe (CAGCP), Department of Meteorology, University of Stockholm, S-10691 Stockholm, Sweden.

Emphasis will be on the long-range transport and deposition of both naturally occur-

Meetings (cont. on p. 698)

Meetings (cont. from p. 697)

ring and pollution-derived trace substances in remote tropical, temperate and polar regions and the impact of these fluxes on regional to global-scale atmospheric chemical cycles. Measurements of atmospheric concentrations from which such fluxes can be inferred will also be included. Additional emphasis will be on boundary-layer-to-surface interactions and on the long-term record of atmospheric chemistry and chemical cycles as revealed in ice cores.

M-3 Clouds and Radiation

Cosponsoring Commissions: CCP, RC, CGL.

Convenors: SA: Andrew Heymsfield (CP), CSIRO/NCAR, P.O. Box 3000, Boulder, CO 80507, USA, and Garth Paltridge (RC), CSIRO, Division of Atmospheric Sciences, Private Bag No. 1, Mordialloc, Victoria 3195, Australia.

The effect of clouds on radiative transfer, especially the cirrus problem, and aspects of cloud-typing and improved parameterization by satellite (e.g., ISCCP considerations).

Convenors: SB: L. T. W. Choulaton, UMIST, University of Manchester, Sackville Street, Manchester M60 1QD, United Kingdom, and Graham Stephens, CSIRO, Division of Atmospheric Sciences, Private Bag No. 1, Mordialloc, Victoria 3195, Australia.

The effect of radiation on the microphysics and mesometeorology of clouds.

Convenor: SC: Alan Arking, Code 915, GSFC/NASA, Greenbelt, MD 20771, USA.

Utilization of earth radiation budget data for climate studies.

M-4 Nowcasting IIa

Cosponsoring Commissions: CCP, CDM, RC.

Convenor: Keith A. Browning (CCP), Meteorological Office, Royal Signals and Radar Establishment, St. Andrews Road, Great Malvern, Worcs. WR14 3PS, United Kingdom.

This symposium is intended to be a brief and predominantly scientific review of the work reported at Nowcasting II, scheduled to be held at Norrköping, Sweden, September 1984. It will consist of mostly invited papers.

M-5 Planetary Boundary-Layer Physics

Cosponsoring Commissions: CDM, RC.

Convenors: Peter A. Taylor, ARCL (CDM), Atmospheric Environment Service, 4905 Dufferin Street, Downsview, Ontario, M3H 5T4 Canada, and William Large (CDM), AARP/NCAR, P.O. Box 3000, Boulder, CO 80507, USA.

The symposium will cover a range of topics on the structure and physics of the planetary boundary layer. Papers on the response of the planetary boundary layer to horizontal inhomogeneities of the underlying surface such as coastal transition zones and on the effects of orographic or topographic features are especially encouraged, as are papers on the physics of fluxes of moisture, gases, heat and momentum at air-water interfaces.

M-6 Role of Air/Sea Interaction in Mesoscale Development

Cosponsoring Commissions: CDM, CDM WG A, and CDM WG C.

Convenors: Eric Rasmusen (CDM), Institute of Theoretical Meteorology, University of Copenhagen, Haraldsgade 6, DK-2200 Copenhagen, Denmark, and Gordon A. McBean (CDM), Institute of Ocean Sciences, P.O. Box 6000, Sidney, British Columbia, V8L 4B2 Canada.

The exchanges of energy, mass and momentum between the ocean and atmosphere play an important role on all scales of atmospheric energetics. This symposium will deal with the role in mesoscale development, mesoscale development may occur as convective cloud systems and as structures embedded in larger-scale phenomena. The session will focus on observations and modeling studies that focus on understanding the physical processes and that lead to better parameterizations for weather and climate modeling. At least one session will be devoted to papers resulting from the Storm Transfer and Response Experiment (STREX).

M-7 Convective Processes and their Feedback on the Large-Scale Motion

Cosponsoring Commissions: CCP, CDM.

Convenor: M. Menzies (CDM), Atmospheric Physics Group, Imperial College, Blackett Laboratory, Prince Consort Road, London SW7 2AZ, United Kingdom.

This session will concentrate on the dynamical aspects of deep convection and the parameterization of convection in large-scale and mesoscale models. Theoretical aspects, numerical models and observational studies will be addressed in order that current progress can be evaluated on a broad basis.

There will be special emphasis on the structure of organized convection and convective systems which are controlled by, or have a direct thermodynamic or dynamic feedback to, the basic flow.

New ideas in parameterization and the verification of schemes against observational data sets and in models will be of particular interest.

M-8 Weather Forecasting in the Tropics

Cosponsoring Commission: CDM.

Convenor: Dave Gauntlett (CDM), Bureau of Meteorology, P.O. Box 1289K, Melbourne, Victoria 3001, Australia.

This symposium will provide an opportunity for discussion on the factors which currently determine the practical limits of deterministic weather prediction at low latitudes. Thus emphasis will be placed on issues such as the impact of new observational systems, on four dimensional data assimilation, initialization and sub-grid scale parameterization techniques. Papers that deal specifically with the predictability of tropical phenomena such as concentrated vortices and line disturbances are also encouraged.

M-9 Comparative Climatology of the Terrestrial Planets

Cosponsoring Commissions: CPAE, CCL.

Convenor: Philip B. James (CPAE), Department of Physics, University of Missouri, 8001 Natural Bridge Road, St. Louis, MO 63121, USA.

This symposium will review the current state of knowledge concerning the climate of the terrestrial planets and their evolution. Particular emphasis will be placed upon the climate and volatile history of Mars, including relevant observations and modeling. Attention will also be given to the evolution of the terrestrial atmospheres and to the use of remote sensing techniques to study planets other than the earth.

M-10 Clouds in Planetary Atmospheres

Cosponsoring Commissions: CCP, CPAE, RC.

Convenor: Sushil K. Atreya (CPAE), University of Michigan, 2455 Hayward, Ann Arbor, MI 48109-2143, USA.

Comparative study of the cloud physics of planetary atmospheres, including relationship of planetary clouds to radiation budget, photochemistry, lightning discharges, and atmospheric evolution. Where appropriate, comparison with the terrestrial cloud physics and morphology will be desirable.

M-11 Remote Sensing Over the Polar Regions

Cosponsoring Commissions: CPM, RC.

Convenors: Erhardt A. Raschke (RC, SCAR), University of Kulu, Kerpener Strasse 13, 5000 Kulu 41, Federal Republic of Germany, and R. J. Renard (CPM), Department of Meteorology, Naval Postgraduate School, Monterey, CA 93943, USA.

The symposium will review current remote sensing techniques including observations from satellites and automatic weather stations and the results obtained, providing an improved knowledge of the physical characteristics of the land and ocean surfaces and of the meteorological elements of the polar regions; but will not review data relay or platform location technical problems.

M-12 Polar and Midlatitude Weather Systems

Cosponsoring Commissions: CDM, CPM.

Convenors: Dave Bromwich (CPM), Institute of Polar Studies, Ohio State University, Columbus, OH 43210, USA, and S. Tibaldi (CDM), ECMWF, Shinfield Park, Reading, Berkshire RG2 9AX, United Kingdom.

The symposium will examine relationships between the larger-scale weather systems in the polar regions and those at midlatitudes on timescales of days to seasons. The symposium will examine the larger-scale weather systems in polar and middle latitude regions and their interaction.

M-13 Variability of Aerosol Optical Properties

Cosponsoring Commissions: CACGP, CCL, RC.

Convenors: Ardesh Deepak (RC), Institute for Atmospheric Optic and Remote Sensing (IFORS), P.O. Box 5, Hampton, VA 23666, USA, and Robert Dickinson (CCL), AARP/NCAR, P.O. Box 3000, Boulder, CO 80507, USA.

Emphasis will be on the following subject: Determination of trends, spatial and temporal variability, and statistics of optical effects in the atmosphere due to aerosols, including radiation transmission, scattering, and absorption.

M-14 Climate Effects of Nuclear War

Cosponsoring Commissions: CACGP, CCL, RC.

Convenors: Barry Pitcock (CCL), CSIRO, Division of Atmospheric Science, Private Bag No. 1, Mordialloc, Victoria, 3195, Australia, and Steve Schneider (CCL), ASP/NCAR, P.O. Box 3000, Boulder, CO 80507, USA.

This symposium will deal with the climate/environmental effects of nuclear war, and will include a report of the SCOPE-ENUWAR project. Contributed papers in the following areas will be considered for inclusion:

- Materials injected into the atmosphere, including papers on fire extent, fuel loadings, smoke composition, dust, and gaseous products.
- Optical, micro-physical and chemical properties and behavior of injected materials.
- Mesoscale processes, including plume rise, scavenging, atmospheric dispersion, changes in vertical stability, etc.

- General circulation and climate, including surface temperature, duration of effects, inter-hemispheric transport, visible and ultraviolet light intensities.
- Climate impact assessment, including effects on animals, crops, and natural terrestrial and aquatic ecosystems.

M-15 Tracing Large-Scale Motions Over the Ocean by Measurements of Atmospheric Electricity

Cosponsoring Commission: CAE.

Convenor: Hans Dolezal (CAE), Coastal Sciences Program, Office of Naval Research, Arlington, VA 22217, USA.

Tracing atmospheric motions over the sea contributes to the study of air-sea interaction, formation of internal and general boundary layers, energy transfer between air and ocean, and to several remote sensing methods. Atmospheric electricity methods offer some potential not duplicated by other methods (WMO Tech. Note 162). Ions can be traced down to 10 to the minus 17 parts, moving with the air, influencing the easily measured electric field and current density. Air-earth current is influenced by air motions aloft. Equipotential surfaces, easily determined, reflect air motions. The purpose of this symposium is to initiate by a small number of papers a discussion on potential and limitation, and on the scope of oceanographic and marine-meteorological needs.

Joint WMO/IAMAP Symposium

WMO Fourth WMO Scientific Conference on Weather Modification

Program Committee: R. G. Soule (France), Chairman; F. C. de Almeida (Brazil); I. I. Bertsev (USSR); A. Gagin (Israel); W. F. Hilschfeld (Canada); R. L. Lavoie (USA); Ma Peimin (PRC); L. R. Koenig (WMO Secretariat).

Topics of the Symposium:

- Physics of Precipitation Processes
- Emerging Techniques of Sensing Microphysical and Dynamical Properties of Clouds
- Scientific Basis for Evaluating Weather Modification Experiment
- Status of Precipitation Modification and Hail Suppression
- Review of Developments as Reported in Recent Meetings
- Future of Weather Modification

Potential authors should send an abstract of their contribution to reach WMO by November 15, 1984. The program committee will review these abstracts and notify authors of their decisions regarding the inclusion of their papers in the symposium. Final papers should be four to six pages in length and be prepared in sufficient time to reach WMO by February 15, 1985. These papers will be published by WMO in a "Proceedings." Abstracts and papers should be sent to: Secretary-General, World Meteorological Organization, Weather Modification Symposium, Case Postale No. 5, CH-1211 Geneva 20, Switzerland.

Related Meetings

The IAMAP Commission on Meteorology of the Upper Atmosphere (ICMUA) will be meeting with the International Association of Geomagnetism and Aeronomy (IAGA) at their Scientific Assembly in Prague, August 1985. For information regarding the IAGA Scientific Assembly, please contact: Mike Gadden, Secretary-General, IAGA, Department of Natural Philosophy, Aberdeen University, Aberdeen AB9 2UE, United Kingdom.

The symposia and workshops which ICMUA is cosponsoring and co-organizing are described below. For more information regarding them please contact: Adolph Ebel, Secretary, ICMUA, Institut für Geophysik und Meteorologie, Universität Köln, D-5000 Köln 41, Federal Republic of Germany.

Acronyms

COSPAR Committee on Space Research
IAU International Astronomical Union
ICACGP IAMAP Commission on Atmospheric Chemistry and Global Pollution
ICAE IAMAP Commission on Atmospheric Electricity
ICCL IAMAP Commission on Climate
ICCP IAMAP Commission on Cloud Physics
ICDM IAMAP Commission on Dynamic Meteorology
ICL Inter-Union Commission on the Lithosphere
ICMUA IAMAP Commission on Meteorology of the Upper Atmosphere
ICPAE IAMAP Commission on Planetary Atmospheres and their Evolution
ICPM IAMAP Commission on Polar Meteorology
ICSU International Council of Scientific Unions
IOC International Ozone Commission
IRG International Radiation Commission
IUGG International Union of Geodesy and Geophysics
IAGA International Association of Geomagnetism and Aeronomy
IAHS International Association of Hydrological Sciences
IAMAP International Association of Meteorology and Atmospheric Physics
IASPO International Association for the Physical Sciences of the Ocean
IAGVCE International Association of Volcanology and Chemistry of the Earth's Interior
JSC Joint Scientific Committee (for the WCRP, ICSU/WMO)
MAS Middle Atmosphere Sciences
SCOSTEP Scientific Committee on Solar Terrestrial Physics
URSI Union Radio Scientifique International
VIRA Venus International Reference Atmosphere
WRCP World Climate Research Programme
WMO World Meteorological Organization

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Symposium 8: Radiation and Chemistry in the Middle Atmosphere

Sponsors: IAGA, Interdisciplinary Commission on the Middle Atmosphere (ICMA) and IAMAP, International Commission on the Meteorology of the Upper Atmosphere (ICMUA).

Convenor: J. Taubenheim (GDR).
Co-convenor: P. C. Simon (Belgium).
Sessions:

- UV Radiations, Cross Sections, Photochem. Modeling
- Solar-Terrestrial Forcing of the Middle Atmosphere
- High-Latitude Phenomena
- Short-Lived Species in the Middle Atmosphere
- Long-Lived Species including Results of MAP-GLOBUS
- Nocturnal Clouds, including Results of MAP-CAMP
- Interaction of Neutral and Ionized Components of the Middle Atmosphere

Symposium 11: Dynamics and Remote Sensing of the Middle Atmosphere

Sponsors: IAMAP, International Commission on the Meteorology of the Upper Atmosphere (ICMUA) and IAGA, Interdisciplinary Commission on the Middle Atmosphere (ICMA).

Convenor: R. G. Roper (USA) (not yet confirmed).

Co-convenor: A. Ebel (FRG).

The sessions of Symposium 11 are devoted to the observation, interpretation and modeling of dynamical processes in the middle atmosphere (about 20–110 km height). Coupling of the middle atmosphere with the troposphere and higher thermospheric layers will also be discussed. One of the main topics will be momentum and heat transport due to atmospheric waves (gravity, tidal and planetary waves) as well as turbulence (2- and 3-dimensional). Symposium 11 is organized in close cooperation with Symposium 8 (radiation and chemistry in the middle atmosphere).

Sessions:

- Progress in Remote Sensing Techniques from the Ground and from Satellites
- Dynamics of the Stratosphere, including Troposphere Coupling
- Dynamics of the Mesosphere and Lower Thermosphere
- Circulation Models of the Middle Atmosphere
- Tides, Gravity Waves and Turbulence
- Climatology of the Middle Atmosphere
- Coupling between Photochemistry and Transport in the Middle Atmosphere
- Winter in Northern Europe including Results from MAP-WINE

Middle Atmosphere Workshops

11.9 Tides in the Middle Atmosphere
Sponsor: ICMUA (IAMAP), Working Group on Tides in the Mesosphere and Lower Thermosphere.

Chairman: J. M. Forbes (USA).

During the two years prior to the ICMUA meeting in Prague the working group will have examined various aspects of deducing tides from data time series, including spectral analyses, filter methods, Fourier fits, and addressing such questions as 'variability' and measures of 'uncertainty' in derived tidal components. Tentative conclusions and recommendations will have been discussed at the Kyoto MAP Symposium in November 1984. One purpose of the 1/2 day workshop at Prague will be to finalize these conclusions and arrange for their publication. A second matter for discussion will be the feasibility and value of developing an observationally-based climatological model of tidal winds and temperatures in the mesosphere and lower thermosphere.

11.10 Downward Penetration of Solar Activity Effects into the Middle Atmosphere

Sponsor: ICMUA (IAMAP), Working

Group on Solar-Terrestrial Relationships.
Cosponsors: SCOSTEP, COSPAR, WMO (to be confirmed).

Chairmen: A. D. Belmont (USA), A. Ebel (FRG).

The aim of the workshop is to contribute to a better understanding of solar-induced changes in the atmosphere through presentations restricted to less controversial topics in the field of solar-terrestrial relationships. Therefore, it is intended to concentrate mainly on effects observed and/or modeled at middle stratospheric heights and above. Contributions about radiation and particle effects, response mechanisms, solar activity data etc., are solicited.

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AGU**Maurice Ewing Medalist:
Xavier Le Pichon****Citation**

Mr. President, fellow members of the American Geophysical Union, and members of the U.S. Navy, I give you great pleasure to present the citation for the 1984 AGU-USN Maurice Ewing Medal, to be awarded to Dr. Xavier Le Pichon.

After receiving diplomas in several disciplines of geology, physics, and geophysics from the University of Strasbourg during the 1950s, Xavier came to the Lamont-Doherty Geological Observatory as a visiting scientist where he put his knowledge to practice until 1968. In 1966 he received the Doctor of Sciences degree from the University of Strasbourg. Returning to France in 1968, Xavier spent the next five years at the Centre Océanologique de Bretagne in Brest where he founded the Research Group from Brest he moved to the headquarters of CNRS in Paris for 3 years and then to the University of Paris to found the new Laboratoire de Géodynamique. From his present position of professor at the university he will move next year to become director of the Geology Laboratory in the Ecole Normale Supérieure, one of the French Grandes Ecoles.

There are many examples of Xavier's scientific accomplishments, and they occupy a very broad spectrum of the marine science disciplines. Author or coauthor of three books and some 150 other publications, he has been a most prolific producer of experimental and observational results and of new ideas. Among his contribution that I am most familiar with are several papers based on his work at Lamont covering a wide range of studies in seismic, gravity, magnetic, and geothermal methods. During this period he was also a major collaborator in establishing the validity of the plate tectonics story, coauthoring several of the key early papers and producing the first global map of plate boundaries and motions. At the same time he was engaged in a major effort in which he combined physical oceanographic observations and seismic reflection surveys into a coherent picture of bottom water circulation and its large influences on the regional sedimentation patterns of the South Atlantic.

Xavier's continuing interest in the plate tectonics theme has resulted in a large number of significant contributions to the refinement of the global tectonic framework. He has shed considerable light on the tectonic development and evolution of rifted continental margins, within a framework of extension, fracture zones, thermal subsidence and sedimentation, and he has been engaged in a monumental study and geodynamic interpretation of the Aegean-Hellenic Arc region of the Mediterranean Sea. A recent addition to his already varied collection of publications, in which he probes more deeply into the earth, is geoid, pangea and convection. Another important area of marine research in which Xavier's participation and influence were prominent factors has been the initiation, with Woods Hole, of Project FAMOUS and follow-on promotion of deep submarine utilization in a variety of studies of the seafloor. A major program to study the Japanese trenches is scheduled to begin next year with the new French 6000 m submarine.

This very brief listing of some of Xavier's work is not intended as a summary but, rather, as an indication of the breadth of his endeavor in pursuit of a better understanding of the earth. The topics of his publications range from ocean circulation to processes in

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